POWER PLANT ENGINEERING

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Serving the Sick

DUPLICATE EQUIPMENT IN POWER PLANT OF MERCY HOSPITAL, CHICAGO, INSURES CONTINUITY OF SERVICE; OPERATING EFFICIENCY MAINTAINED BY DUAL DRIVEN AUXILIARIES

ONE OF THE OLDEST, largest and still most modern hospitals to be found in the city of Chicago is Mercy Hospital, the buildings of which occupy the greater part of that city square bounded by 25th St. on the north, 26th St. on the south, Prairie Ave. on the west and Calumet Ave. on the east. This institution is conducted by the Sisters of Mercy for the alleviation of the sufferings of the sick and the injured, and incidentally also for the training of nurses.

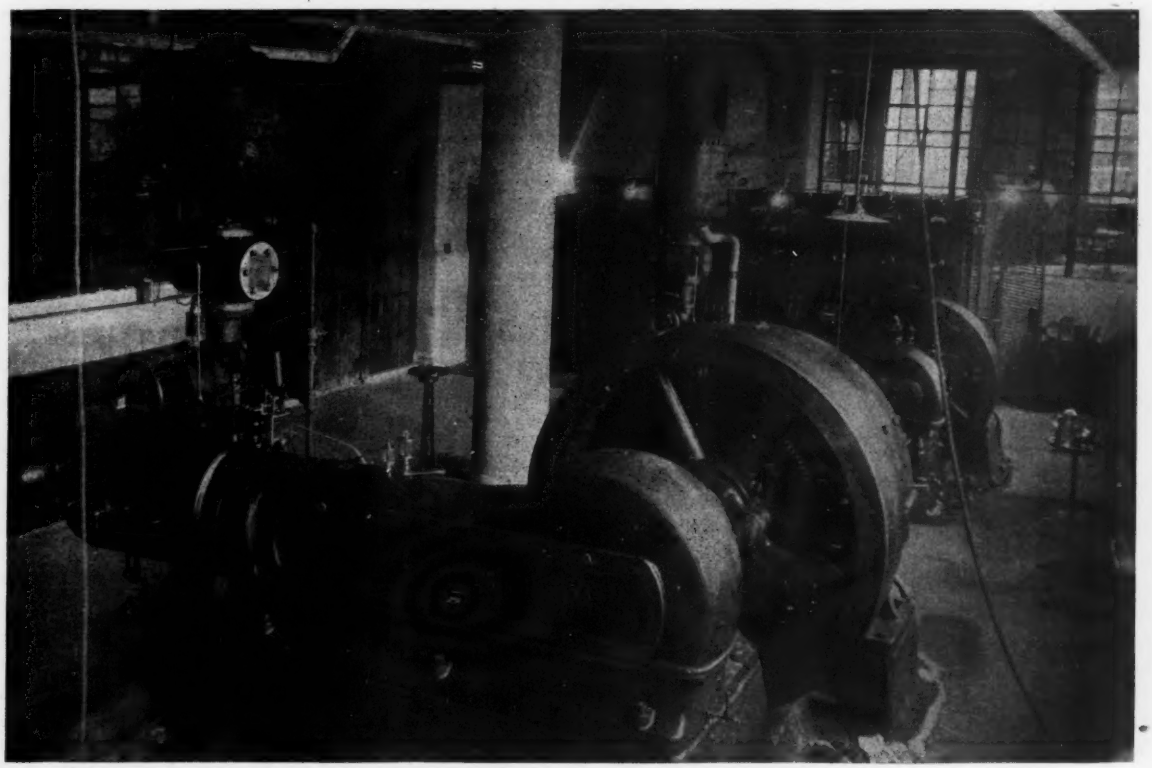


FIG. 1. GENERAL VIEW OF ENGIN E ROOM DURING CONSTRUCTION

Of late the growth of this hospital has been quite phenomenal and in order to eliminate a somewhat crowded condition in certain quarters, and thereby provide accommodations for a larger number of patients, there has been erected and recently placed in use a service building, for the purpose of housing all those departments which in any way contribute to the necessities, conveniences and comforts of both the sick and the well. Built of steel, concrete and brick, this structure, which is six stories in height and is located near the corner of 25th St. and Calumet Ave., contains the power plant, the laundry, the servants' dormitories and various repair shops.

Naturally, the basement was selected for the power plant, the general arrangement employed being as indicated in the plan and elevation shown in Fig. 3. Occupying the southern half of the basement are the boiler room and coal bunkers; adjacent to this are the pump and heater rooms, while along the north side and with

a length equal to the width of the 25th St. side of the building, is in the engine room, which also includes the office of the chief engineer, P. H. Mahoney. Glass partitions separate these sections of the plant and serve not only to provide ample natural illumination during the hours of daylight, but also give an almost unobstructed view through the engine and heater rooms into the boiler room, a feature of much convenience to the operators.

Coal is delivered to the plant in wagons and trucks, and shoveled into the coal bunkers which have an approximate storage capacity of 900 tons. From here it is again manually transferred to the stoker hoppers, although this method is but temporary, as the architect's plans call for the installation of an electrically operated monorail system which will reduce the cost of handling the fuel and tend to increase the efficiency of the boiler plant to a considerable extent.

An American steam jet conveyor removes the ashes from the receiving chambers below the boiler furnaces and discharges them into a 10-ton concrete bin built integral with one of the coal storage bins. From this

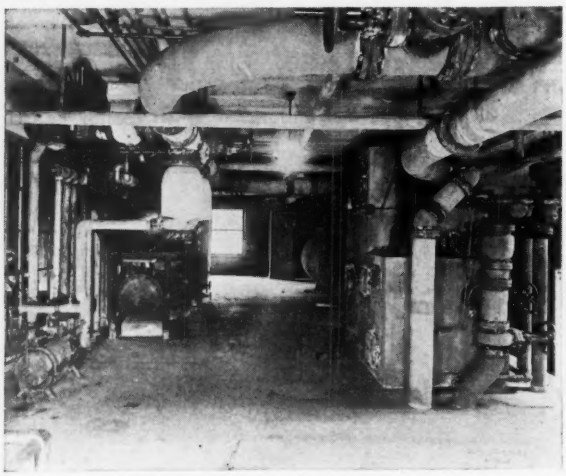


FIG. 2. THE HEATER ROOM

point they may be discharged by gravity into wagons or trucks and hauled away.

Boilers, which are of Heine make and rated at 353 hp. each, are of the single-drum type having 48-in. shells and 203 3½-in. tubes, providing a total heating surface of 3535 sq. ft. They rest upon foundations consisting of concrete mats ranging in thickness from 8 to 12 in., and carrying 31-in. side walls and a 26-in. rear wall of the same material; the bridge wall is supported by a cross wall 29 in. in thickness. Above the floor level, the setting walls are of brick with a thickness of about 22 in. up to the fire line above which they are reduced to 19 in. Between this lining and the outside wall is a 1-in. air space.

Furnaces proper have a depth of about 10 ft. and a width of 7 ft. 4 in., while the combustion chamber is 7 ft. 4 in. long and 7 ft. 11 in. wide.

Continuity of service, elimination of waste and a high degree of efficiency were given considerable attention by the designers of this plant, as is evidenced by the type of equipment installed and the arrangement of apparatus employed. Each boiler feed line is fitted with a recording thermometer and in order to determine the actual performance of each steam generating unit, the steam leads connecting these with the main header are each equipped with General Electric recording steam flow meters, the instruments being placed on the walls opposite the boiler fronts so as always to be within plain sight of the firemen.

Water may be fed to the boilers by means of either one of two feed lines, one of which is under manual control, while the other is used in conjunction with Copes regulators. These have proved within the short time the plant has been in operation very reliable and according to the chief engineer, practically no attention need be given the boiler whatever as far as feeding is concerned, as long as the regulators are in service.

The stokers, which are of Laclede-Christy make, may be operated either by electric motor or a small high-speed steam engine, the drive employed depending upon the demand for exhaust steam. In winter, when this is comparatively heavy, the engine is used, while during the summer months, when the steam is employed only for domestic purposes, such as laundry work and in the kitchens, and the load on the electric generators is naturally quite light, the motor is operated. This procedure tends not only to provide a maximum of exhaust steam when this is in greatest demand, but also places upon the generating units a more uniform load, thus allowing these machines to operate at the highest degree of efficiency.

Steam is normally generated at a pressure of 150 lb. gage and through the medium of 6-in. leads fitted with Lunkenheimer stop and check valves of like size is delivered to a 12-in. main high-pressure header carried along the boiler room wall in front of the boilers. Connected to this header through two 6-in. bends is a short 6-in. auxiliary header which, in turn, by means of one 5-in. and one 6-in. branch, serves the various pumps, the heating system, the laundries, the kitchens, etc. And in order to prevent any possible shut-down or interruption of service due to failure of any section of the piping system, or any one of the steam generating units, the header, after being reduced to 6 in., is laid out on the ring or circulating plan with valves provided to allow cutting out any part for repairs without in any way affecting the operation of the plant. Two 150-kw. generating sets are each supplied with steam through 6-in. branches, while a 4-in. lead connects with a 75-kw. unit. Each of the engine leads is fitted with a Griscom-Russell steel steam separator and a Falls automatic engine stop placed directly ahead of the throttle valve.

After passing through a Webster oil separator, the steam exhausted by the engines is discharged into a 14-in. exhaust main by means of which it is distributed to a Warren Webster feed-water heater provided with a Lea V-notch meter, the heating system and the domestic service lines. A 4-ft. by 10-ft. 6-in. expansion tank connected to the 14-in. exhaust main in the manner indicated in Fig. 3, cares for any excess of steam which may accumulate on account of an oversupply of exhaust and acts as a reservoir tending to maintain a constant pressure on the distributing lines. And in order to insure against a shortage of low-pressure steam, live steam may be introduced into this tank through a 10-in. inlet

in turn supplied from the 6-in. auxiliary header branch through the medium of either one or both of two pressure-reducing valves connected in parallel. With this arrangement, the feed-water heater, the heating system, and the domestic service lines may at all times be supplied with the requisite amount of low-pressure steam regardless of the load on the generating units and auxiliaries.

The 14-in. exhaust riser which extends to the roof of the building is fitted with a 14-in. Eclipse back pressure valve and a Sorge exhaust head, thus insuring the prevention of damage to the system due to overpressure and the escape of excess steam to the atmosphere.

As in the high-pressure steam distribution system, interruption of boiler feed has been guarded against by the installation of duplicate equipment. Two 9 by 5 by 10-in. Worthington duplex pumps which are fitted with interconnected suctions and discharges feed a set of two 3-in. lines carried along the tops of the boilers. These lines are again interconnected at each boiler so that with the scheme of piping and valving employed, either one or both of the feed pumps may be operated and either one or both 3-in. lines used to feed the boilers. Each of the pumps is equipped with a Fisher governor.

Drums and rear water legs may be cleared of sediment and scale through 1½ and 2-in. tie lines, respectively, connecting with a 4-in. blowoff main discharging into a 42-in. by 8-in. sheet steel blowoff basin which, in turn, empties into a 24 by 30-in. receiving tank connected to the city sewers.

In the Engine Room

Here is found the main electric generating equipment consisting of two Chandler-Taylor-Sprague Electric units, one of 75 and the other of 150 kw. capacity,

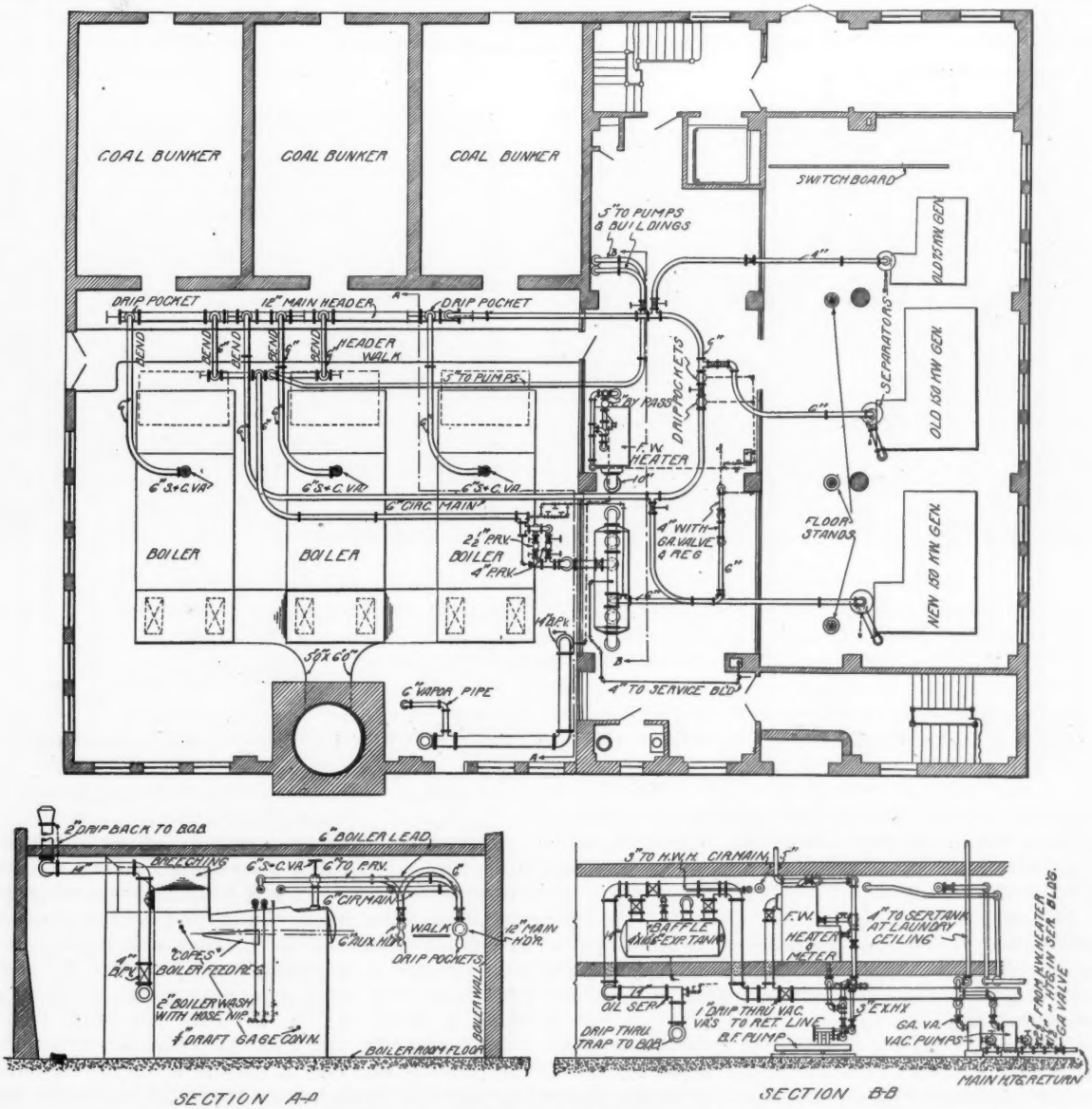


FIG. 3. PLAN AND ELEVATIONS OF POWER PLANT

and one 150-kw. Ball-Crocker-Wheeler set. Each of these delivers current to a 3-wire distribution system at a voltage of 250, with 125 v. across either of the outside lines and the neutral, the latter being employed for power service exclusively, while the 125-v. supply is for lighting purposes. The balancer sets, of which there are 2, are of Sprague-Electric make and are each rated at 6¼ kw., 125 v.

At the west end of the engine room and directly below the engineer's office is, as may be seen by referring to Figs. 1 and 3, the switchboard. This is of black slate and is made up of seven panels, three for the generators, one for the balancer sets and the remaining three for distribution control. The rear is enclosed by grille work of iron, thereby allowing access to none but authorized persons.

The only other equipment of consequence in the engine room are two small motor-generator sets delivering current at a voltage of 15 for use in conjunction with the signaling and annunciator systems used in the various buildings.

Although in the old sections the annunciator with its frequently distracting buzzer is still employed, silent systems of signaling have been installed in the most recently erected parts.

When requiring the services of a nurse or other attendant, the patient uses the ordinary form of push button, which instead of announcing the call on the ordinary form of annunciator board causes two lamps to be lighted, one directly above the door of the patient's room, and the other at a signal board on the desk of the supervising floor nurse, which indicates the number of the room from which the call originated. These signals continue in operation until the nurse reaches the bedside of the summoning patient, and again opens the circuit controlling these lamps by means of the push button pendant.

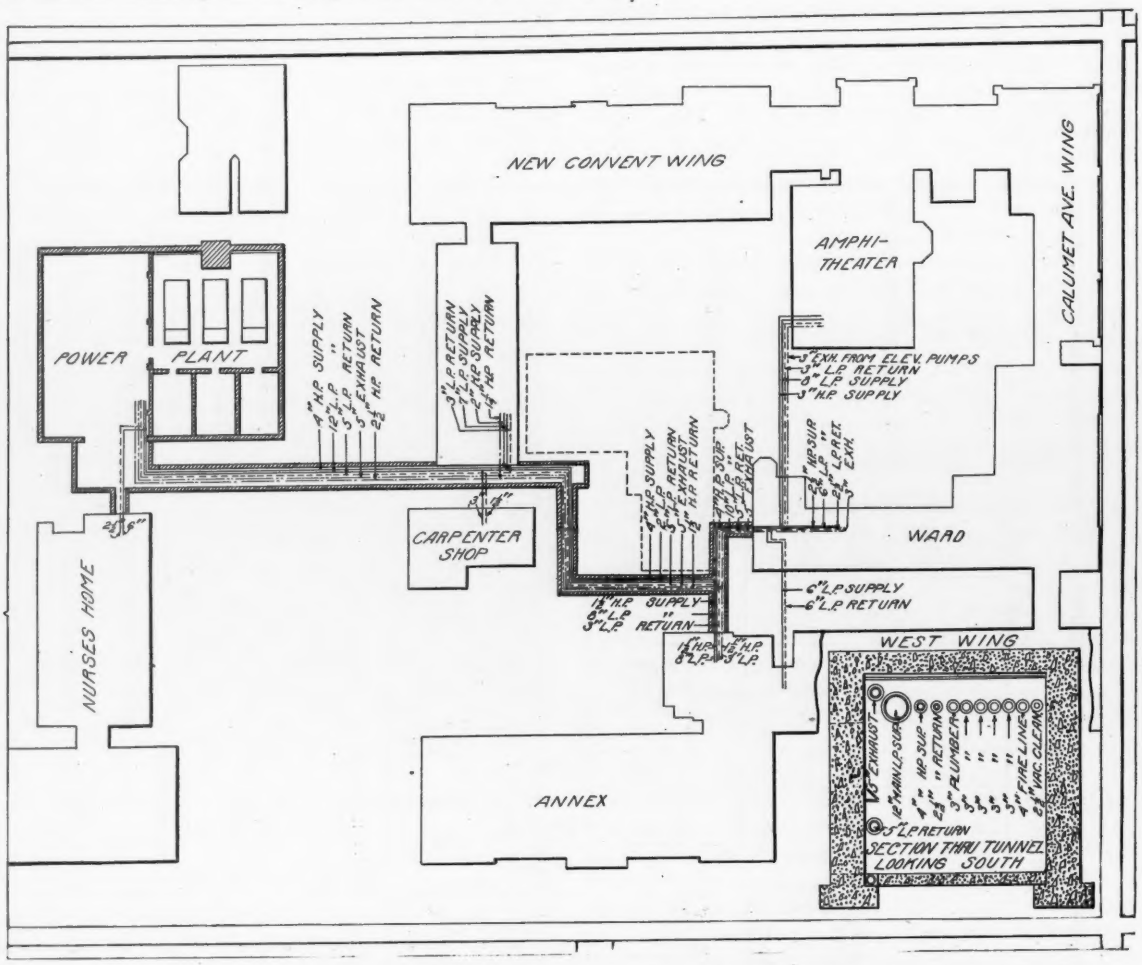


FIG. 4. SERVICE DISTRIBUTION SYSTEM AND TUNNEL SECTION

Steam Distribution

ONE OF THE INTERESTING FEATURES of this installation is the steam distribution system employed between the power house and the various buildings comprising this institution. Two exhaust lines, one the 14-in. main extended and another of 5 in. and a 4-in. high-pressure main are carried to a point directly west of the pump room where they enter a concrete tunnel, a section of which is shown in Fig. 4. Here the 14-in. line is reduced to 12 in. and with the others is continued to and past the west end of the new convent wing where 3½ and 7-in. branches are taken off the 12-in. low-pressure line for the carpenter shop and the new convent

wing; the latter is also supplied with high-pressure steam through a 2-in. branch connected to the 4-in. high-pressure main. The trench then follows the course indicated in Fig. 4, from a study of which we note a 1½-in. high-pressure and two low-pressure branches of 6 and 8 in., respectively, entering the annex, a 2½-in. high-pressure and a 6-in. low-pressure branch the wards, and two low-pressure branches of 3 and 8 in., respectively, and one 3-in. high-pressure branch the amphitheater. Returns are handled by one 2½-in. line and one 5-in. line, the former for high-pressure and the latter for low-pressure service.

Eccentric flanged fittings are used in both low and high-pressure supply mains wherever reduction in pipe sizes occur and gate valves are placed on all lines where they enter the buildings. High-pressure lines are fitted with pressure reducing valves in the buildings they serve.

The 5-in. low-pressure return line, upon entering the pump room, connects with a 5-in. suction header of two 8 by 12 by 12-in. Blake-Knowles vacuum pumps which discharge the condensate through 4-in. lines into a service tank in the laundry on the floor above. Returns from two hot water heaters and those from the heating system in the service building are also handled by these vacuum pumps.

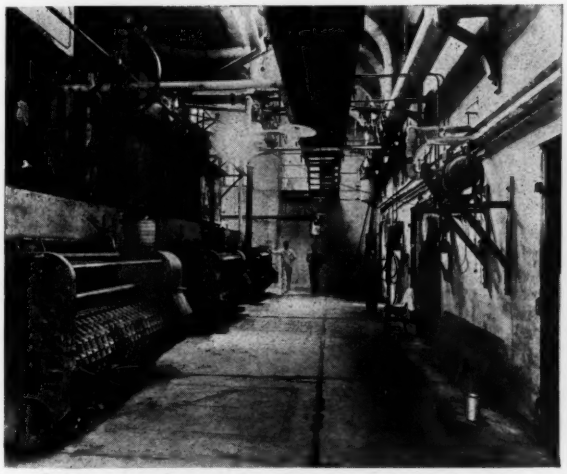


FIG. 5. THE BOILER ROOM, MERCY HOSPITAL

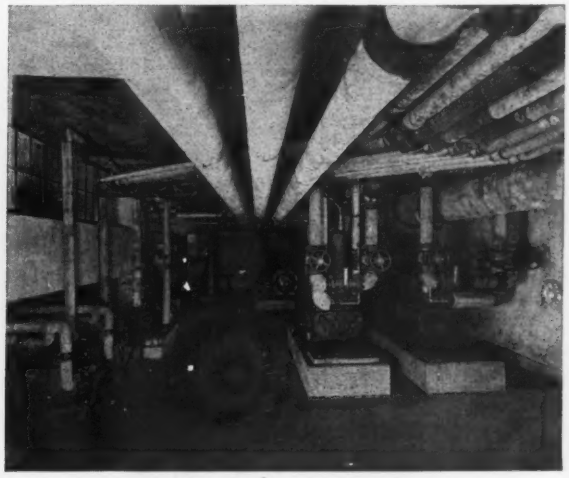


FIG. 6. THE PUMP ROOM

All high-pressure returns from the heating system, main pipe lines and steam apparatus are piped to direct return traps which discharge into the feed-water heater.

Crane-tilt traps are used exclusively throughout this installation.

Steam is supplied to the various buildings for heating purposes only during those months it is required, with the exception of the delivery rooms and nurseries, which are supplied by means of a separate high-pressure line equipped with a reducing valve so that they may be heated at any time during the year.

The Water Supply

When considering that this institution has housing accommodations for over one thousand persons, it becomes quite evident that provision must be made for a positive and continuous supply of both hot and cold water, the latter not only for domestic use, but also for fire protection purposes. And while much of the pumping equipment installed for this service may be found in the pump room of the plant, some of the buildings have been provided with independent systems, with the units in each case electrically driven.

Cold water for the old buildings is taken from six service tanks having an average capacity of approximately 4000 gal. These are supplied either by a 7 by 8-in. Deane of Holyoke triplex pump belted to a 10-hp. Crocker-Wheeler motor, or a 6 by 10 by 6-in. Worthington duplex pump, both of which are electrically controlled by means of floats in the tanks above. The motor-driven pump is intended to be operated only during the summer months when the demand for exhaust steam is comparatively light and the electric load not heavy, while the steam-driven pump is to be used during those months that the demand for low-pressure steam is greater and the lighting load is heavier. The scheme of operation followed and the results sought are the same as those in the case of the stoker operating units previously mentioned.

In the more recently constructed additions, the compression system is used throughout, each building having its individual unit. The one installed in the service building and which, although somewhat larger, is of the same type as found in the nurses' home and the Calumet Ave. annex, is employed not only as the source of cold water supply for the service building, but also furnishes hot water to all of the other buildings.

The hot water system is of the circulating type. Part of the cold water leaving the compression tank in the pump room is piped to and discharges into the suction line connecting the circulating pump to the heater, and only enough water is drawn into the system to make up for that used. Check valves, one in the circulating pump suction line and the other in the branch adjoining this with the compression tank discharge, prevent the hot water backing up into the cold water system.

The compression tank used in conjunction with this system has a capacity of approximately 1400 gal. and may be supplied by either one of two centrifugal pumps, each of which is driven by a 5-hp. Roth electric motor.

The circulating water pump is of Worthington make and ordinarily maintains a pressure of 150 lb.

Each building has its individual sewage disposal system. As discharged into a receiving sump in the basement, the sewage is taken up by one of two Yeomans vertical centrifugal pumps, each of which is driven by a 2-hp. electric motor under float control, and delivered into the city sewers.

Wickes Boiler Construction

EFFICIENT CIRCULATION, DRY STEAM AND ACCESSIBILITY FOR CLEANING ARE INCLUDED IN THE ADVANTAGES OF THIS VERTICAL WATER-TUBE BOILER

THIS is a typical vertical water-tube boiler, consisting primarily of a steam drum and a mud drum, one placed directly above the other, and connected by straight tubes. These tubes are expanded and rolled into both tube sheets, and are divided into two sections by a fire brick baffle, which extends upward to about 4/5 of the length of the tubes.

Although similar in their diameter and general construction, the steam and mud drum differ in height and arrangement of convex heads, the steam drum having the greater height. The height, diameter and thickness of both drums is varied in accordance with the size of boiler desired and local requirements. Shell plates are rolled from one sheet and joined by a butt and strap seam.

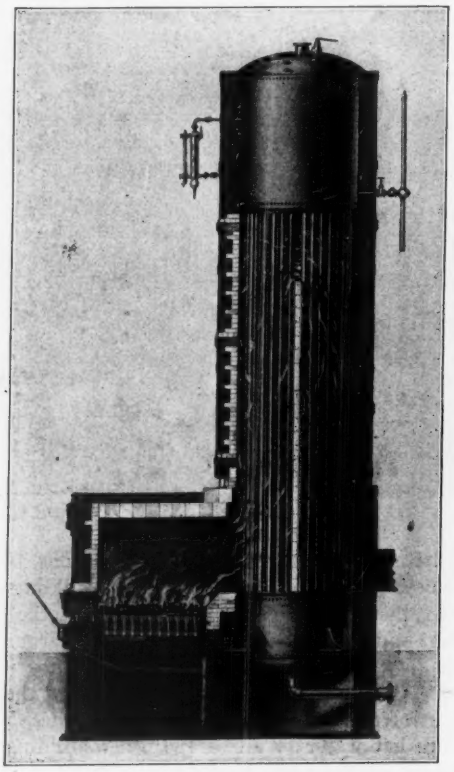


FIG. 1. WICKES VERTICAL WATER-TUBE BOILER

In order to make a thorough inspection or to clean the tubes, one large manhole is placed in the convex head of the steam drum, and another manhole is placed in the bottom or side of the mud drum. The steam drum is large enough for a man to stand upright while cleaning the tubes, and the tube sheet and convex head are joined together by heavy braces which are so located that the easy movements of a man in the drum may not be hampered and still provide equal tension on all the parts.

At the lowest point on the mud drum is placed a heavy pressed steel mud pot, to catch sediment, tapped for a 2½-in. extra heavy blowoff pipe.

Tubes on this boiler commonly have an outside diameter of 4 in. and a length up to 22 ft. Those in front of the dividing baffle are called "risers" and those in the rear compartment are termed "down-comers," since the heat and the water mingled with the steam rise in the forward tubes and both the heat and the water descend among and in those forming the rear compartment.

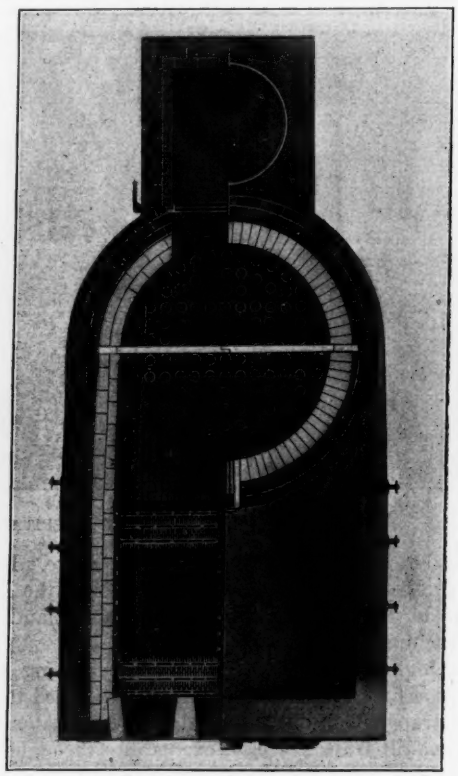


FIG. 2. PLAN VIEW OF WICKES BOILER

As shown in Fig. 2, the tubes are arranged in parallel rows and sufficient space is provided between rows to permit the introduction of a small hoe, or soot blowing lance, to remove any deposit of soot or dust which has fallen from the tubes and accumulated on the tube sheet of the mud drum.

This boiler is supported by 4 pressed steel lugs substantially riveted to the shell of the mud drum, and

resting upon heavy plates firmly imbedded in the masonry. The design is such that the boiler is free to expand and contract independent of and entirely free from the brickwork.

Dutch Oven Type Furnace

All furnaces employed with this boiler are of the Dutch oven type and may be hand fired, or provided with any class of mechanical stoker. Special wedge fire brick form the arch over the furnace, and the weight of the boiler setting is removed from the arch by the I-beams, as shown in Fig. 1. These I-beams are arranged in box form and are so placed as to permit a constant flow of air between them, thereby preventing expansion from a rise in temperature.

As the boiler is entirely enclosed in brickwork, the hot gases surround all of the tubes and part of the steam drum. Exposing the steam drum to the products of combustion provides superheating surface, which tends to dry the steam thoroughly, thereby producing dry steam.

Feed water may be introduced into the steam drum directly over the "down-comers" and far below the

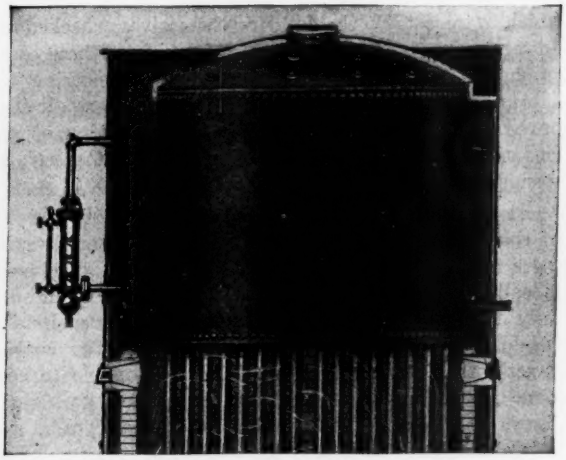


FIG. 3. VIEW SHOWING DOOR FOR TUBE REMOVAL

water line, or in the mud drum at a point above the precipitated sediment. Because of the fact that the water becomes warmed before entering the mud drum and precipitates its sediment more easily, the first method is recommended, except in cases where water contains large amount of calcium carbonate, when the second method is recommended. After flowing downward through the tubes in the rear compartment and passing through the mud drum, the water rises through the forward tubes to the steam drum, from which any water not evaporated retraces its course.

To insure complete submersion of the tubes, the water line in the steam drum is usually carried about 30 in. above the tube sheet, and sufficient space is provided between the water line and the top of the steam drum to provide for the liberation of steam.

On a level with the water line, and extending over the tubes in the front compartment, is a baffle plate which deflects the water rising with its steam directly to the "down-comers." This prevents splashing and spraying of the steam chamber directly above with globules or masses of water. The baffle plate is arranged on hinges and is held in normal position by pins, so that when entering the drum for cleaning, the pins may be withdrawn and the baffle plate thrown up to a vertical position against the brace rods.

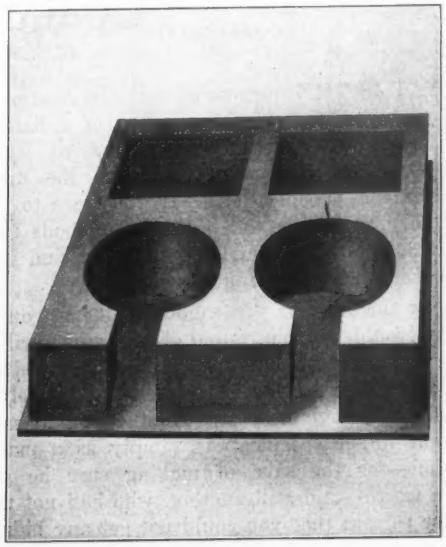


FIG. 4. FOUNDATION FOR A BATTERY OF TWO BOILERS

Safety valves are attached directly to the boiler head with studs, by means of which the flange of the safety valve is bolted to the boiler head. In the smaller boilers, the steam outlet is a pressed steel studded head faced.

To provide for tube renewal, the brickwork in the front pass of the boiler is carried away from the tubes,

FIG. 5. ERECTING WICKES BOILERS

leaving a passage-way through which the front two rows of tubes, if damaged, can be quickly renewed without drawing the tubes through the hole in which they are expanded.

To provide for the renewal of the remainder of the tubes in the boiler, handholes are conveniently arranged in the convexed head, through which damaged tubes are passed for renewal. The tubes are rolled into the steel tube sheets with a Dudgeon expander and the ends flared out with a flaring tool after they have been expanded.

Fire brick baffle tile are 3⅛ in. thick, rabbeted at the vertical joint and tongue and grooved at the horizontal joint.

Coal Specifications*

Why They Are Used and How Abused

WHAT IS THE purpose of coal specifications? If you were to ask this question of a half dozen coal buyers, you would, in all probability, get a half-dozen different answers. Such is the unsettled position of coal specifications. If you were to go still farther and ask for the details of the methods followed by your half-dozen coal buyers, you would find yourself in a confusing array of countless variations.

Among the answers you would receive to your question, you would find one would claim emphatically that the purpose of specifications was simply to reduce the cost of coal, while another would just as positively claim that they increased the cost. Another would say that he bought under specifications simply as a matter of protection—for the sake of making sure he got his money's worth—and still another, who had not tried it, would be certain that you could not get any bids under specifications anyway. If we were to examine into the individual experience and methods which produced these varying opinions, we would find in each case a flaw in the methods, or a faulty or only partial understanding of the principles underlying the scientific purchase of coal.

Coal specifications have been and are being used successfully today in the purchase of hundreds of thousands of tons of coal, but only where the purpose has been clearly defined in advance, and the methods carefully perfected in the light of wide experience in coal selection and in the use of specifications themselves.

Coal Selection and Valuation

THE chief purpose of coal specifications is to furnish a method by which the buyer pays for the coal at a price which varies, up or down, as variations occur in the value of the different lots of coal delivered. Along with this goes the idea of protection, of certainty on the part of the buyer of getting exactly what the seller has agreed to deliver, and of extra compensation to the seller if he delivers better coal than has been agreed upon. Now if this is the prime function of specifications, should they not be introduced, after we have put into practice the most effective measures for the selection of the right kind of coal, of the best coal of that kind for the money, and after we have provided means to check up on the quality of the goods delivered; then we will be in a position to consider the question of final protection. Then we can, by means of properly drawn specifications, make certain of the advantages of our already well-developed plan. Many coal consumers think that specifications will automatically solve the problem of coal selection, and then after trying to buy under specifications without a thoroughly organized plan of coal selection and purchase, blame the principle of specification buying for their failure. It is a simple case of getting the cart before the horse, and of course it doesn't work.

Specification Buying is Fair

BUYING on specifications is fair and just to the coal dealer or miner. But the methods frequently adopted for the execution of the plan may completely defeat the real purpose of the specifications.

In one particular case, as in many others, the majority of the bidders showed that they knew how their coal would average, for the standards of quality which were set by the bidders themselves, checked up quite closely with the records established by these coals, as shown by the records in the Fuel Engineering Co. Library of Coal Records, with which they were all compared. And this brings us to a consideration of one element in coal specifications which may in itself determine the success or failure of the plan.

It is obvious that if the amount to be paid per ton of coal is to rise or fall as the value of the coal varies, there must be a starting point. This starting point is called the Standard, and this Standard should not only include the character and quality of the coal stated in definite terms and the price per ton for coal of exactly that quality, but it should be possible to combine the quality of the coal and the price into a single figure by the same method which is proposed to be used in determining variations in settlement prices. When this is possible, bids can be accurately compared with each other and both the consumer and the bidder will be able to determine easily in advance just how much will be paid for coal which varies a given amount from the standard quality. The Standard is intimately related to the method of determining the settlement price of each shipment. This should be so arranged that variations in price follow as nearly as possible the corresponding variations in the actual value of the coal to the consumer. There is no justification for arbitrary and unrelated price corrections, simply based upon the principle of penalty for not fulfilling the terms of the contract. Increases in price for coal above the standard quality should be at the same rate as decreases in price of similar variations below that Standard. Not only is the dealer entitled to this, but it is manifestly good policy for the buyer, because if the bidder must stand decreases in price without any chance to obtain more money for better coal, he must either make his price high enough or his standard of quality low enough to compensate him for this unfair risk he is called upon to assume.

*From a Business Talk by the Fuel Engineering Co., of New York.

Penalties are Enforceable Regardless of Clauses

In a lecture before the Detroit Engineering Society, in which the legal side of penalty and premium contracts was explained, Edward Henderson announced that from the standpoint of law the penalty clause might as well be left out of a contract, as for every evasion of right there is compensation. No stipulation of damages need be mentioned. If a penalty clause is in a contract, it will not stand unless the damages are compensatory. If the Court finds that the penalty is a fair measure of the damage sustained, there it stands, but if the penalty is greater than the damage sustained, then the Court will decline to allow penalty. Penalty can only be a measure of damages. There is no relation between bonus and penalty.

The question of validity of bonuses has not been settled. Enforcement of a bonus depends upon whether it is a fair deal; that is, whether it is a fair compensation to the contractor for the extra effort put forth in completing the contract, or is a measure of value received by the owner.

That a penalty can be enforced at law even though there is no penalty clause in the contract is elementary to any one familiar with the law of contracts, yet in spite of this many coal dealers are willing to write letters to a prospective customer guaranteeing positively that their coal runs so-and-so, and are glad to have the buyer accept the offer unconditionally, although those same dealers will not bid under specifications, if they can help it. They do not seem to realize that the contract made in this, or some similar way, actually makes them liable to the same kind of penalties to which they would be subject under specifications. When this is the case, would it not seem wise if the seller always insisted that the adjustments of price in accordance with the quality be determined in advance, specifically stated and agreed upon, rather than run the risk of having the buyer make deductions which might perhaps be actually larger than could be maintained in Court, and with the reasonable certainty of having to accept these deductions in part or whole at the end of an expensive law suit, if he tried to put the customer's estimate of damages to the test? The reason that this is not the case is that relatively few customers keep an accurate check on the quality of coal delivered, and are therefore in no position to assert their rights.

Improperly Drawn Specifications May be More Dangerous to Buyer than to Seller

Specifications which are drawn without a clear conception of their true purpose, and a thorough knowledge of the fundamental principles of coal selection and without adequate records of the quality of the various coals to be purchased, are likely to place the buyer in the position of taking a bigger gambling chance than any of the bidders, and with most of the odds against him from the start. To illustrate this point, as well as some of those previously mentioned, take the specifications sent out by a certain concern whose plant is located in the central part of New York State. The name of the concern is withheld, although no confidence would be violated by disclosing it. Otherwise the copy is exact and complete:

"Bids will be received by..... on 8000 tons of bituminous coal, 2240 lb. per ton, to be of approximately the following analysis:

Moisture	1%
Volatile	20%
Carbon	74%
Ash	5%
Sulphur, not over	2%

"In bidding please state the number of B.t.u.'s per lb.

"Deliveries to be made in fairly even monthly quantities during the year beginning April, 1915.

"The successful bidder is to stand a correction to the gross weight as a result of the analysis compared to the standard above.

"No. 1. *Moisture.* The gross weight of the coal shall be reduced by the amount the analysis shows over 1%.

"No. 2. *Ash.* The gross weight of the coal shall be reduced at the rate of 1% for each per cent of Ash in excess of 5%.

"The percentage of Ash shall be computed to the nearest tenth of a per cent.

"No. 3. *Volatile Combustible Matter.* The gross weight of the coal shall be reduced at the rate of 2% for each 1% of volatile combustible matter in excess of the standard.

"No. 4. *Sulphur.* The gross weight of the coal shall be reduced at the rate of 3% for each 1% of volatile sulphur in excess of the standard.

"No. 5. *Heat Unit Variations.* The gross weight of the coal shall be reduced at the rate of 1% for each 100 B.t.u.'s below standard heating value, and shall be increased at the rate of 1% for each 100 B.t.u.'s above the standard.

"The deductions and additions shall be computed to the nearest 50 heat units.

"Aggregate Changes in Gross Weight to Produce Net Weight:

"All percentages in deductions and additions, as above prescribed to be made shall be aggregated and totalized, and shall be deducted and added as the case may be, as a whole, and payment shall be made only for the balance of the gross weight."

In these specifications an arbitrary standard of quality has been adopted by the purchaser, although the heat value is left for the bidder to supply. Incidentally it should be noticed that these specifications do not indicate whether the bidder is to supply the B.t.u. dry or the B.t.u. as received. If the B.t.u. as received is meant, the moisture penalty is a duplication of a part of the B.t.u. penalty, and absolutely unjustifiable. If the B.t.u. dry is meant, then this buyer has a part of his Standard on one basis and a part on another. Whatever was meant, it is nowhere indicated, and yet these specifications go under the name of "scientific coal buying."

Nothing is gained by setting a Standard for the bidder, while much is lost. It is sometimes advisable to insert in the specifications a general description of the

character and quality of coal desired, although a better way is to know in advance what coals fall within the classification desired, and then to get bids only on those coals.

Every coal is different in character and quality from every other, although these differences may be slight. It is better policy to let the bidder set his own Standard, and then select the best bid giving consideration to both the standard of quality and the price. In case this is done, however, the buyer should have at his command adequate records with which to compare the bids, for the acceptance of a bid containing a Standard, which the previous record of the coal showed could not be maintained, would lead only to dissatisfaction on both sides. This is a not infrequent occurrence, because many dealers and miners are still very much in the dark as to the real quality of their own coals.

Unreasonable Standard

In the above Standard the first item is interesting—"Moisture 1%." The only way a coal shipper could comply with this would be to air-dry the coal carefully under cover, and ship it in sealed glass bottles. Semi-bituminous coal, which is the kind called for by the Standard, will average from 2.5 to 3.5 per cent in moisture, and occasionally higher. This means that every bidder under these specifications must put his price up 1.5 to 2.5 per cent to take care of the moisture penalties which are specified. Leaving the volatile and carbon items for the present, we come to—"Ash 5%." Of all the 20 per cent volatile coals which could be shipped to this concern, the very best of them would average between 6 and 7 per cent in ash, and there are mighty few of those. Again each bidder must mark up the price he really wishes to get for his coal to take care of the inevitable ash penalty. No wonder some people say that prices go up, when you buy under specifications.

Unreasonable Penalties

Next comes the method of determining the settlement price, or perhaps more correctly the "list of penalties." This part starts off—"The successful bidder is to stand a correction to the gross weight," etc., but why correct the weight when you can't? The correct weight is determined, or should be, by means of scales. It is definite and easily obtained. Why not say—"The *price per ton* will be corrected," when this is what is *meant?* Then why penalize for volatile? The miner cannot control the volatile as he can the ash and sulphur, and as long as the coal is shipped from the same operation, the volatile will vary within quite narrow limits. Any material change in volatile would come from the substitution of some other coal, in which case the buyer presumably does not want the coal at all, and should be able to cancel the contract or reject the shipment. The specifications in question, however, do not provide for the rejection of any coal, no matter how poor it may be. It is usually not worth while, in buying any product, to insist upon conditions which have no material value to you, when those same conditions make your business much less attractive to the seller. This illustrates another reason why some people have experienced higher prices when they have tried to buy under specifications.

The last price correction calls for the deduction of 1 per cent of the price for each 100 B.t.u. less than the Standard, although in a coal of the kind called for in these specifications, 100 B.t.u. is equivalent to only seven-tenths of one per cent of the value. The same amount is added to the price if the B.t.u. is higher than the Standard, but there are no corresponding increases in price for lower ash, moisture or sulphur. If you add an extra 1 per cent of ash, you displace 1 per cent of combustible matter, equivalent to about 150 B.t.u. in this case. The decrease in price for 150 B.t.u. below the Standard is 2.5 per cent because of the additional ash penalty, while the increase in price for 150 B.t.u. above Standard is only 1.5 per cent. In short, these five price corrections are absolutely unrelated to each other, bear little relation to the anticipated variations in the value of the coal, and are based upon an impossible and partially indefinite Standard to start with. But this is the least of it, for any specifications are next to useless, if not actually dangerous, when it is not possible to determine exactly what certain coals will cost under them.

Which Bid?

Take for example two bids on coals which will not average, however, as low as 5 per cent ash, which might be made under these specifications. This is a perfectly fair test of the specifications, for experience has demonstrated that dealers will frequently bid on coals which are decidedly inferior to an arbitrary standard prescribed by the buyer. Now assume that in this case the following two bids were received, it being remembered that the specifications require the bidder to furnish only the B.t.u. in addition to the price:

1. 14,000 B.t.u. .....$3.18 per ton
2. 14,264 B.t.u. .....$3.24 per ton

Now knowing only the B.t.u., which each one guarantees, and the price, which bid is the better to accept? As a matter of fact, the ratio between the two B.t.u. Standards is the same as the ratio between the two prices. On the face of it, one bid is as good as the other. It is obvious that we must have more facts about these two coals than this buyer had or asked for, if we are to make a trustworthy comparison of these two bids.

Here are the complete figures on these two coals—the average results on many past deliveries, which is the best guide to what they will do in the near future, although the record of the past is no positive indication of the future. To avoid hopeless chaos, we have made both of our hypothetical bidders bid alike, and furnish the B.t.u. as received in each case.

	No. 1.	No. 2.
Moisture	3.00%	3.00%
Ash	8.00%	6.50%
Volatile	20.50%	19.00%
Sulphur	1.65%	1.85%
B.t.u. as received	14,000	14,264

Assuming that each of these coals will average during the year like this, let us see just what each coal would cost under these specifications. Here are the deductions in per cent:

	No. 1.	No. 2.
Moisture	2.0%	2.0%
Ash	3.0%	1.5%
Volatile	1.0%	None
Sulphur	None	None
B.t.u.	None	None
Total deductions	6.0%	3.5%

Deducting 6 per cent from the price of No. 1 coal, which is $3.18, we get a final cost of $2.99, and 3.5 per cent from $3.24, the price of No. 2, leaves $3.13 for this coal, a difference of 14 cents a ton. The relative value of the two coals, on the basis of the amount of heat delivered for the money at the corrected prices, is about 6 cents a ton, leaving a purely artificial difference of 8 cents. If the buyer who did not have these facts had guessed, for it would have been nothing better than a pure guess—if he had guessed wrong, it would have cost him $640 for his 8000 tons. This is by no means an extreme case, and illustrates the continual danger that a buyer of coal runs, with such specifications, and without adequate records to guide him. When it is further considered that a dealer, who would bid under such specifications which include many penalty chances, and only one small premium chance, would probably add 10 cents a ton for "safety," there is piled up against these particular specifications an aggregate of not only possible but probable losses which makes the good old Guess-all-along-the-line method look like a sure road to economy by comparison.

To Sum Up

The coal buyer who intends to adopt specifications must have clearly in mind just exactly what he can expect to accomplish by their use.

Primarily, the purpose of specifications is to make *certain* of obtaining coal of the character and quality which perfected methods of coal selection have indicated should be obtained, and equal to, or better than, the previous record which the particular coal under consideration has already established.

The specifications must be so constructed that all bids can be reduced to the same basis for comparison.

The method of price correction must be based upon sound principles of coal valuation, and not on a more or less vague idea of arbitrary "premiums and penalties."

The buyer must fortify himself with comprehensive and accurate coal records as a basis for comparison, and to protect himself against reckless and impossible Standards. There is little to be gained by buying a coal which is guaranteed to run 5 per cent in ash and 15,000 B.t.u. dry, when the coal will actually average nearer 10 per cent ash and 14,000 B.t.u., even though severe deductions in price are made.

The sampling and testing methods must be thoroughly reliable, and the reports prompt.

Some of the results will be: (1) The risk of maintaining the quality of the coal will be shifted from the buyer, who has no control over it, to the seller who is the only one who has any control over it; (2) If the standard quality is not maintained, the buyer makes a saving in the consequent reduction of the price, because that reduction would not have been obtained if the same coal has been bought without any specifications; (3) There is a constant incentive to the shipper to furnish coal equal to or better than the Standard, and this invariably leads to lower fuel costs in the long run, even though substantial premiums are paid, providing the Standard is a fair one; (4) Many coals of varying degrees of quality are all placed in a position of being judged strictly on their merits, and lower prices almost invariably result, probably because the competition between the various coals is made much closer in this way.

Turbo-Generator Operation

Difficulties Encountered and Some Remedies Resorted to in the Operation of a Small Turbo-Generator Set. By W. J. S.

THREE turbo-generators which have been partly under my care for the past two years are of the direct connected type and run at 3600 r.p.m. The generator is alternating current, 60-cycle, 2300-volt, 3-phase, with the exciter carried on the end of the generator shaft without an outboard bearing, and is rated at 469 kv.a. This rating, however, is questionable, since the instruction book sent with the machines states that the kv.a. rating is 469 at 80 per cent power factor, which will be observed is unusual, as the kv.a. rating was adopted for the purpose of relieving the manufacturer of any concern or responsibility for the power factor of the load which the generator carries. Our power factor is no doubt fairly high, although no meter is installed to indicate it, and at least the true rating of the generator has never caused us any concern, since the turbine would barely furnish enough power to drive the generator at its rated load (assume 375 kv.a. unity p.f.) much less to overload it any considerable amount.

The turbine is of the impulse type with six revolving bucket wheels of 32-in. mean diameter, and the running clearance is ⅛ to 3/16 in., so that no clearance or bucket trouble has been experienced. Saturated steam at 155 lb. gage is used. It is with the valves, the governor, the main nozzle ring, the low-pressure stuffing box and the bearings of the entire set that I have been chiefly concerned. The first three items will be discussed first, for they are the most important as affecting the economy in the use of steam, the power which the turbine is capable of delivering, and are responsible in part for the other difficulties encountered.

By referring to Fig. 1, the layout of the steam supply, the valve ports, and the main nozzle ring will be seen. All the steam supplied to the turbine first comes through the main valve, which is of the double-balanced poppet type and takes steam in the center and discharges it top and bottom into the chest to supply the regular nozzles, approximately 12 in number. In the same chest with the main poppet is a balanced piston valve so set that after a certain load is reached it takes

steam which has already been admitted by the main valve and passes it into the overload port and through the overload nozzles, approximately five in number.

These two sets of nozzles are supposed to take care of all loads from no load to a certain overload with a vacuum of 26 to 27 in. On the left-hand side of the machine is a third valve, also of the balanced piston type, which is supposed to be used as a noncondensing feature or for any condition of vacuum below normal, and this valve takes steam also from the main nozzle port and passes it into a third port leading to the main nozzle ring. This third port was also supposed to be equipped with nozzles according to the instruction book.

All three of these valves are operated in unison from a bell crank actuated directly by the governor, except that the no vacuum valve is carried on a floating lever and is supposed to be under the control of a diaphragm chamber which in turn was supposed to be piped to the condenser, so that this valve could be given an independent movement under conditions of no vacuum or low vacuum. As the machines were installed by the factory, this no vacuum valve diaphragm chamber was not piped to the condenser, so it can readily be seen that the valve was not a noncondensing or low vacuum feature in any sense. It was further found that this valve was originally set to come in after a load of about 250 kw. had been reached.

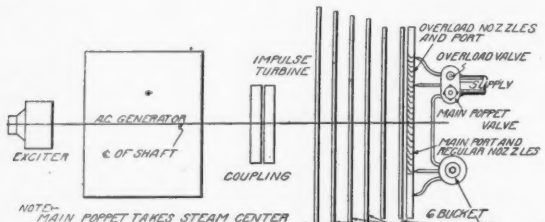

OVERLOAD NOZZLES AND PORT
OVERLOAD VALVE
IMPULSE TURBINE
SUPPLY
MAIN POPPET VALVE
AC. GENERATOR
EXCITER
℄ OF SHAFT
MAIN PORT AND REGULAR NOZZLES
COUPLING
NOTE-
MAIN POPPET TAKES STEAM CENTER DISCHARGES, TOP AND BOTTOM.
℄ BUCKET WHEELS
OVER LOAD VALVE TAKES STEAM TOP AND BOTTOM, DISCHARGES CENTER.
NO VACUUM OR BYPASS VALVE AND PORT
BY PASS VALVE TAKES STEAM CENTER, DISCHARGES TOP AND BOTTOM.
SEPARATORS AND NOZZLES NOT SHOWN.

FIG. 1. CROSS SECTION OF TURBO GENERATOR

I puzzled over this condition of affairs till it finally became necessary to overhaul one of the units, due to excessive vibration caused by the shaft being out of round. With the turbine dismantled and the rotor sent to the machine shop for truing up, a thorough examination of the main nozzle ring and ports was made, and it was found that the port supplied by the no vacuum valve was not supplied with nozzles. It was thus evident that this valve was being used as a bypass to admit high-pressure steam into the first wheel space without being directed through nozzles, and as this valve was coming into play after a load of 250 kw. had been reached regardless of vacuum conditions, that the turbine rating of 375 kw. must be considerably in excess of the power that the regular and overload nozzles would actually deliver.

With the bypass valve working the turbine would, however, deliver its rating and a little more, that is for a very short time only, as the steam thus admitted would cause an unequal pressure on the two sides of the first wheel, and set up an end thrust which was disastrous to the low-pressure or thrust bearing. The thrust bearing on these machines is, strictly speaking, more of the nature of an end play bearing to keep the running clearance between the nozzles and buckets correct, and consists only of four small rings turned on the shaft and running in grooves in the babbit of the bearing shells. Under normal conditions when the bypass valve was not open, the only end thrust was that due to the tension on the synchronizing spring (and this was kept at a minimum); there was no end thrust due to the action of the steam, since in a turbine of this type the expansion takes place in the nozzles, and the pressure throughout the wheel space is about equal. It will thus be seen that the thrust bearing was not designed to take care of any great amount of end thrust such as was occasioned by the bypassing of steam to the first wheel space in this manner.

It occurred to me that possibly the main poppet valve was too small, so when the turbine was finally assembled a 2-in. steam line was connected to the steam chest of the bypass valve (with the valve removed and the port leading to the hole in the nozzle ring blanked off), in such a manner that steam could be admitted through a hand operated valve to the main port supplying the regular and overload nozzles. Enough load was then applied to the turbine (about 250 kw.) to cause the governor to assume a position where the main poppet and overload valves were practically wide open, and the first stage or nozzle pressure showed 120 lb. When more load was applied, the speed commenced to drop and the

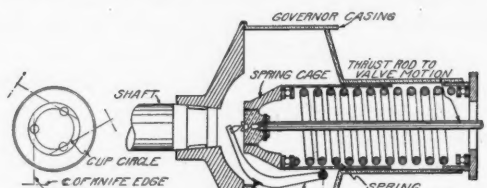


FIG. 2. FLYBALL GOVERNOR FOR TURBINE

extra line was opened wide by hand. The nozzle pressure came up to about 140 lb., but the turbine still continued to fall off in speed till it got down to 2900 r.p.m. This seemed to show that not more steam but more nozzles were needed.

At the time of these trials, it was not thought practicable to run two of the sets in parallel as a regular performance, as we had too much trouble with burnt out bearings and dirty condensing water; so the bypass was put in service again in order to take care of the momentary loads in excess of 250 kw., and two sets were paralleled whenever a steady load in excess of that amount was expected. More recently, however, since some improvement has been made in the quality of the condensing water, and an improvised oil changing and filtering system for the bearings has been installed, it has been found feasible to run two of the sets at all times except when the current for the railway is not required. This method, while no doubt somewhat wasteful of steam, has increased the quality of the service immensely and saved much trouble with burnt out bearings, since the load on either turbine does not, except in rare cases, reach a value in excess of 250 kw., so that the bypass valve does not come into play under these conditions.

The governor is of the flyball type (see Fig. 2) and is secured to the tapered end of turbine shaft by a tapered key. The flyballs are three in number and these impart a sliding motion to the spring cage, the points of contact being hardened steel points and cups. It will be observed that the flyball points have two functions, that of forcing the spring cage outward against the spring, and also of keeping the end of spring cage in a central position so that it will run true. The center line of each flyball is tangent to the circle upon which the cups in the end of spring are located, so that as the points move through their arc a slight twisting motion is imparted to the spring cage.

Distances center to center of the cups are always equal and the same, but there are only two points on the arc described by the flyball points, i.e. at rest and extreme outward position when at full-speed, where the distance center to center of the points is the same as that of the cups, so that at all other positions on the arc there is a tendency for the points to climb the sides of the cup or to break. If all three points climb equally, the cage is not thrown off center; but if one stays in the center and the other two climb, then the cage is not running true and more or less vibration results.

The points as originally designed were rather sharp, having a tip with a radius of 1/64 in., and as the sides of the cups were straight, we were continually in trouble due to the breakage of points. Several different styles of points and cups have been tried out, and finally we have found that points with a ⅛ in. radius on the tip working in cups of ¼ in. radius have given good results during the past six months. It is true that this sacrifices something in that it introduces slightly more friction, but the gain in reliability more than compensates for this.

We have always had more or less trouble with speed regulation which was sluggish, due to the fact that the governor was direct acting and had to overcome the friction of the various levers and valve stems. Recently I have removed the overload piston valves entirely from the chests in order to allow the regular and overload nozzles to work together at all loads. This was done to get rid of the friction of one valve stem and piston valve, and to get quicker response to sudden changes of load. I reasoned that since the manufacturer had evidently either overrated the turbine or not supplied enough regular nozzles to care for all loads up to full load, that the removal of the overload valve to allow both sets of nozzles to work together at all times, would be a step in the right direction. The results have been very satisfactory, but I am not prepared to give any data on the relative economy of steam before and after the valve was removed. As some one has said, however, the economical use of steam in small sets like these is based more on theory than fact.

Bearings

We have had a tremendous amount of bearing trouble with these sets, such that it is unusual for the bearings to last longer than 30 days without having to remove shims and line up the entire set, and I have seen times when we were running only one set and the bypass valve was coming into play frequently, that the low-pressure bearing would hardly last a week.

The trouble is no doubt due to lack of a proper lubricating system. Each bearing shell both top and bottom is cast iron made hollow for water cooling, and the oiling system as originally supplied consisted of two oil rings and the usual reservoir for each bearing, with no provision for changing, filtering, or cooling the oil except by hand. Recently, we installed an oil pump and filter in the basement, and piped the filtered oil to all three sets, with two sight feeds and needle valves for each bearing. An overflow line was fitted to each reservoir to carry the oil back to filter in basement. This scheme, although only improvised and installed out of pick-up material, has been a great help, and it is now contemplated to carry the oil feed line to the brine tank and back again to obtain the much needed cooling of the oil. What we really need, however, is a real forced feed oiling system with new bearing shells, designed to introduce the oil into the lower shell against the shaft, and then I am sure our troubles with babbit and vibration would disappear. The manufacturer has been asked to supply such a system, I believe.

Low-Pressure Stuffing Box

This consists of an impeller chamber into which water at about 35 lb. pressure is forced, and which forms an effective seal against leakage of air into the vacuum. With this type of stuffing box, or perhaps with this particular stuffing box, it is impossible to run these sets noncondensing and carry any amount of load, as the steam pressure blows the water out past the babbit labyrinth packing against the bearing, or better, the lack of vacuum in the exhaust head allows the water to leak outward instead of drawing it in. If the water is shut off, the steam itself blows out and heats the bearing. Therefore since it is neither practicable nor desirable to operate these sets noncondensing, the manufacturer has been asked to supply nozzles for the port supplied by the bypass valve, and let this valve function as an overload valve and assist the other nozzles.

The water supplied to the low-pressure stuffing boxes and the five automatic relief valves in the plant, is very hard and deposits considerable scale on the sixth bucket wheel of the turbine as well as on the outside of the condenser tubes. To overcome this difficulty, I have proposed the installation of a small pump, controlled by a suitable pressure regulator to take condensate (temperature about 100 deg. F.) from the condensate line to the heater, and pump it to the various points to be used for sealing purposes. This would have the two-fold benefit of getting rid of the scale forming water in the seals, and would give us more complete control over the raw water which must be introduced for makeup.

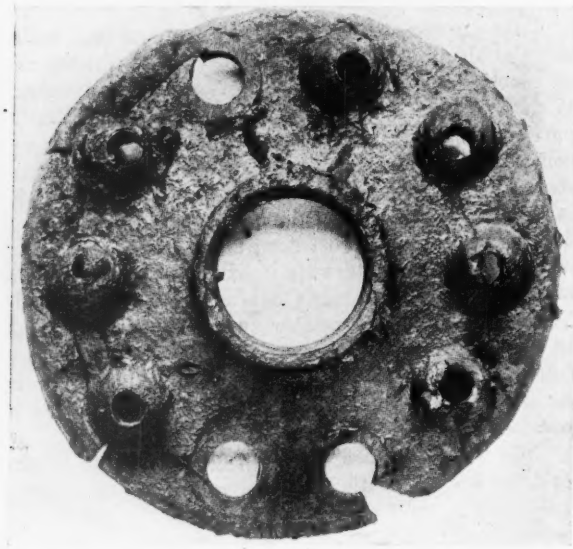
Sodium Hydroxide and Boiler Steel

In certain sections of Illinois, notably the central eastern part, including Bloomington, Champaign, Hoopeston and Danville, also in the Fox River valley about DeKalb, a water has been used for boiler feeding which contains considerable amounts of sodium salts, chiefly carbonate. It was found that under the heat action in the boiler, part of these would decompose and

form sodium hydroxide (Na OH), no scale being formed as the salts from the water would be precipitated by this reaction and easily blown out.

It was found also that certain faults developed in boilers in these regions, such as fine cracks from rivet holes into the surrounding plate, or between rivet holes, or even from rivet holes to the edge of the plate where there was little or no tensile stress. These cracks were below the water line and in boilers observed at the University of Illinois were in connection with a leak or other condition that promoted concentration of the sodium hydroxide solution at those points where the cracks occurred. The illustration of a blowoff flange from a 260-hp. boiler shows the character of the faults. Leakage about this flange was at the outer edge, none at the center; and all cracks have developed in the outer part of the flange.

As a help in determining the cause of the trouble, studies were undertaken at the Engineering Experiment Station of the University of Illinois on the effect of certain chemicals when brought into contact with



BLOWOFF FLANGE OF A 360-HP. STIRLING BOILER

iron and steel so as to set up a chemical reaction, and the results are given in Bulletin No. 94 by S. W. Parr, from which the data of this article have been taken. The experiments were based on the facts that in the districts mentioned, where several boiler explosions during the last 20 yr. have been apparently due to the same cause, whatever it may have been, the soluble salts in the water, after precipitation has taken place, were largely sodium carbonate and hydroxide, with a minimum of chloride and sulphate present. As stated, cracks form below the water line, with leakage and exterior incrustation of a strongly alkaline character present, and in the water a considerable amount of sodium hydroxide or caustic soda (Na OH).

Studying past history, it was found that J. H. Andrew in Transactions of the Faraday Society, March, 1914, was able to demonstrate that strips of steel, after being submerged in concentrated caustic soda solution at 100 deg. for from 1 to 7 weeks became brittle, the reaction being accompanied by evolution of nascent hydrogen. The brittle effect was more noticeable during early stages of the submergence, increased during the first few weeks, but ultimately disappeared, so that malleability was restored.

These results agree with those of the University experiments which showed that caustic soda of sufficient strength attacks iron, generating hydrogen. This hydrogen enters into the iron in such a way as to modify its physical properties, but the effect is transient, and, after a period of freedom from the hydrogen action, the iron returns to its normal condition.

Sodium carbonate has no action on iron, hence no hydrogen is evolved due to its presence, but the carbonate may at certain temperature and by withdrawal of carbon dioxide vapor, and adding of carbonated water react to form caustic soda. Some salts, such as chromates, tend to stop the caustic soda action and sulphates act to dilute the caustic soda, but the degree of concentration of caustic needed to produce harmful action was not determined.

Experiments were made with steel wire kept in caustic soda solutions of 10, 25, 50 and 70 per cent strength and tests made for tensile strength, elongation and electric potential after the treatment.

Results showed that the wire heated to from 100 to 200 deg. C. in solution of higher concentration than 10 per cent, in a sealed tube, showed a small increase in elongation and considerable lowering of the breaking strength. The potential also became greater, which is explained by the taking up of the hydrogen.

In another series of tests on soft steel wire, the tensile tests showed no effect of caustic soda treatment on tensile strength, but on repeated bending tests the number of alterations to produce rupture was about 80 per cent after treatment of that to rupture the fresh material. The brittleness increased for about a week, then the material recovered, partially or wholly.

To overcome the effect of the caustic soda in boilers, the simplest method, used by the University of Illinois, is to add magnesium sulphate to the water, thus forming sodium sulphate, which remains in solution without action on the boiler steel, and magnesium hydroxide which settles as a sludge provided no ammonia compounds are present in the water. One pound of magnesium sulphate per 1000 gal. of water will take care of 3 grains per gallon of sodium carbonate.

Sodium dichromate was also tried, but considerable formation of caustic soda took place within the boiler; also chromium hydroxide was precipitated and tended to fuse as an incrustation on the heated tubes.

Sulphuric acid has also been tried and in the proportion of 0.54 lb. per 1000 gal. of water, for about 8 mo., keeping the concentration of the caustic soda solution down to about 8 per cent of the total solids.

It is not yet certain whether this is low enough to avoid the embrittling effect or not, but careful control must be exercised, if the free acid is used, to avoid forming an acid mixture. The advantage is in cost and avoiding adding further solids to the water.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Reducing Operating Costs*

CONSIDERABLE SAVING TO BE REALIZED BY ADAPTING 220-250-V. CIRCUITS TO LAMPS OF THE 110-125-V. CLASS

IN ORDER to profit by the advantages of lamps of the 110-125-v. class, the practice of operating two lamps in series across 220-250-v. lines has met with favor in many industrial installations, where severe operating conditions and long hours of service make the use of the more rugged, less expensive, and more efficient low-voltage lamp particularly attractive. Under these circumstances, however, slightly less than normal life is to be expected from the lamps, for although two new lamps usually operate satisfactorily in series, one lamp naturally fails sooner than the other, and when a replacement is made, the resistance of the two lamps will be higher than that of two new lamps and less than that of two old ones, for the resistance of lamps increases with burning. Hence, the new lamp will receive slightly less than normal current and will give less than normal candle-power, while the old lamp will be forced to carry a somewhat heavier current than it would normally carry at that period of its life and will, therefore, fail earlier than it otherwise would.

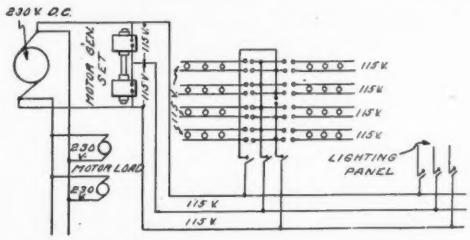


FIG. 1. METHOD OF CONNECTING MOTOR-GENERATOR SET IN DIRECT-CURRENT CIRCUIT

A more serious disadvantage of operating two lamps in series is that the failure of either lamp means the outage of both; thus a relatively large area is left without sufficient light and the time of several persons may be lost while the defective lamp is being located and the replacement made.

PROVIDING 110-125 V. FROM 220-250-V. CIRCUITS

FEW are the modern installations where provision is not made for supplying 110-125 v. for the lighting circuits. The larger installations often generate alternating current, which is, of course, readily transformed to 110-125 v. for lighting. The energy needed by such apparatus as requires direct current is obtained by converting the alternating current to direct current. In new plants in which direct current is generated and maximum flexibility in the control of motor speeds is desirable, or where the lighting load is a considerable portion of the total load, the present practice is to install a 3-wire generator, which provides between the third wire and either main, half the main line voltage. Where the lighting load is a small proportion of a large total load and a very flexible motor speed control is not essential, the installation of a balancer set will, in general, provide greater economy.

The largest field of the 220-250-v. lamp is, then, in plants where 220-250-v. circuits are already used for lighting circuits. In such cases, except small installations, the most satisfactory and the most economical lighting results are secured by providing 110-125-v. circuits by placing a balancer between the 220-250-v. lighting feeders and running a third, or neutral, wire to the main distributing points. The purpose of the balancer is to maintain equal voltages on the two sides of the 3-wire circuit despite unequal loading. For alternating-current circuits, a simple balancer coil suffices; for direct-current, a small mechanically coupled shunt or compound wound motor-generator set is commonly used.

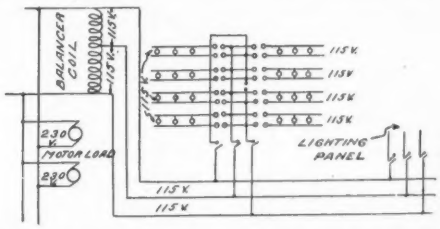


FIG. 2. METHOD OF CONNECTING BALANCER COIL IN SINGLE-PHASE ALTERNATING-CURRENT CIRCUIT

Figures 1 and 2 show a method of connecting the balancer for adapting the 230-v. circuits to 115-v. lamps. The motor-generator set, or the balancer coil, is connected between the 230-v. mains, and a neutral wire is run to the panel boxes. The power load connections require no alterations. Three-wire panels can usually be substituted for two-wire at moderate expense; or, if thought advisable, a three-pole switch may be substituted for the two-pole in existing boxes and a small section removed from the center of one of the bus rods. The two outside wires are then connected, through the switch, to opposite ends of the split bus, and the neutral is connected to the continuous bus rod.

*Abstract of Bulletin 31 of the Engineering Department of the National Lamp Works of General Electric Co.

The method of connecting a balancer coil to a single-phase circuit is shown in Fig. 2. Where three-phase lighting circuits are used, balancer coils may be connected in each phase, but the neutral points cannot be grounded. Since the current which the balancer must carry is determined by the degree of unbalancing, the capacity of the apparatus required in any given case depends upon the magnitude of the lighting load and upon how nearly the conditions of installation will allow the circuits in the panel boxes to be made to balance. Obviously, the greater the number of properly connected circuits, the smaller the chance for serious unbalancing to occur. In practice, the size of the balancer installed ranges from about 10 per cent of the total connected load to 20 or even 25 per cent, depending upon the size of the lighting load and upon how well the circuits may be divided.

Economy of Lamps of the 110-125-v. Class

In determining whether or not a saving can be effected through the use of lamps of the 110-125-v. class, three factors should receive attention:

First—Lower cost of lamps of the 110-125-v. class.

Second—Higher efficiency of lamps of the 110-125-v. class.

TABLE I. COMPARATIVE DATA ON 110-125-V. AND 220-250-V. MAZDA LAMPS—PRICES AS OF AUG. 1, 1917

Size of Lamp in Watts	25 Mazda B	40 Mazda B	60 Mazda B	100 Mazda B	100 Mazda C	200 Mazda C	300 Mazda C	400 Mazda C	500 Mazda C	750 Mazda C	1000 Mazda C
List Price, 115-volt	$0.27	$0.27	$0.36	$0.55	$1.00	$2.00	$3.00	$4.00	$4.50	$6.00	$7.00
List Price, 230-volt	$0.33	$0.33	$0.45	$0.80	------	$2.20	$3.60	$4.80	$5.40	$7.20	$8.40
Approximate cost of 230-volt in per cent of 115-volt..	122	122	125	123	------	110	120	120	120	120	120
Lumens, 115-volt....	226	372	576	996	1260	2920	4850	6150	8050	12800	18000
Lumens, 230-volt....	190	330	516	900	------	2520	4100	5600	7400	11500	16100
Light of 230-volt in per cent of 115-volt.....	84	89	90	90	------	86	85	91	92	90	90

Third—Superior performance of lamps of the 110-125-v. class.

The first two factors can be directly evaluated; the third, while equally important, cannot be readily expressed in terms of dollars and cents.

Table I gives the list price and the light output for comparable wattages of lamps of the 220-250 and 110-125-v. classes. It will be noted that the list price of the various sizes of 220-250-v. lamps is, with a single exception, at least 20 per cent more than that of the corresponding sizes of 110-125-v. lamps. Since 220-250-v. and 110-125-v. lamps have equal average life ratings, the difference in price applies not only to the initial purchase, but to renewal purchases as well. What this difference will amount to per year will depend, of course, upon the number of hours the lamps are operated. If they are in operation 4000 hr. per year, the yearly difference will, on the average, amount to approximately 80 per cent of the cost of one complete installation of lamps.

If 220-250-v. lamps operated as efficiently as lamps of the 110-125-v. class, equal numbers of either class would be required. However, it is seen by reference to Table I that, on the average, the higher voltage lamps give only about 90 per cent of the light which corresponding sizes of the lower voltage lamps give; hence, for equal illumination intensities, more wattage in 220-250-v. lamps is required than is necessary where 110-125-v. lamps are used. In certain cases, the number of units which may be used advantageously is closely limited by the constructional features of the building. In such cases, 220-250-v. lamps of higher wattage and, frequently, the purchase of more expensive reflector equipment, are required. In case conditions are such that considerable latitude in the location of units is afforded, lamps of equal wattage may be considered, but a greater number of the higher voltage lamps will be required. This will entail the installation of more outlets, the purchase of a greater number of reflectors, sockets, etc., and a heavier maintenance expense. In all cases, whether in the design of a new installation or in the altering of an existing installation, cost comparisons should, of course, be based on actual conditions.

The method of making cost comparisons in the case of a new installation is illustrated by the following typical example:

A large industrial plant has just been built in which it is desired to install the most effective and the most economical lighting system. From considerations of the nature of the work, the character of the walls and ceiling, the total area to be lighted, the type of reflector equipment, and the proportions of the interiors, the total quantity of light necessary is computed. It is found that the necessary light can be obtained from 650 200-w. 115-v. or from 750 200-w. 230-v. Mazda C lamps. For the sake of simplicity, it will be assumed that the layout of the plant permits sufficient freedom in the location of units to allow either 650 or 750 units to be spaced advantageously. On this basis, Table II has been computed.

TABLE II. METHOD OF CALCULATING SAVING IN THE USE OF LAMPS OF THE 110-125-V. CLASS

SAVING ON FIRST COST OF UNITS		
Voltage of Circuit	115	230
Wattage of Lamp	200	200
Light Output, Lumens	2,920	2,520
Number of Units Required	650	750
Cost of Lamp (Approximate, on $2500 Contract)	$1.42	$1.56
Cost of Lamps for Complete Installation	$924	$1,170
Saving on First Cost of Lamps	$246	
Number of Units Required	650	750
Cost of Reflector, Socket, Etc., Estimated	$2.00	$2.00
Cost of Reflectors, Sockets, Etc., for Complete Installation	$1,300	$1,500
Saving on First Cost of Reflectors, Sockets, Etc	$200	
TOTAL SAVING ON FIRST COST OF UNITS	$446	
ANNUAL SAVING		
Fixed Charges on Complete Installation:		
Interest at 6 per cent on Investment in Units	$135	$160
Depreciation at 12½ per cent on Reflectors, Sockets, Etc	$163	$188
Cleaning at 36 cents per Unit per Year	$234	$270
Total Annual Fixed Costs	$530	$618
Annual Saving in Fixed Cost	$88	
Energy (4000 Hrs. Operation per Year, 1 cent per Kw-Hr.)	$5,200	$6,000
Annual Energy Saving	$800	
Lamp Renewals (4000 Hrs. Operation per Year)	$3,690	$4,680
Annual Saving in Lamp Renewals	$990	
TOTAL ANNUAL SAVING	$1,878	

Assuming that the lamps are purchased on a $2500 contract, the cost of 115-v. lamps for the initial installation will be about $246 less than that of 230-v. lamps. The lamps require similar reflector equipment, and, assuming a price of $2 for reflector, socket, etc., the initial saving on equipment amounts to $200. The saving on the first cost of 115-v. units is, then, $446. This saving is independent of how many hours the installation is in operation per year. The more the system is used, the greater this yearly saving will be, for

more lamps will be replaced and more energy will be used.

The annual saving calculated on the basis of 4000 hr. operation per year is included in Table II. The annual fixed charges have been taken as: interest on the total investment in units at 6 per cent; depreciation on the reflector equipment at 12½ per cent; and monthly cleaning of the units at $0.36 per unit per year. The annual saving in fixed costs on the units amounts to $88.

Energy costs have been calculated on the basis of 1c per kilowatt-hour; this rate is lower than actual cost in all except very large plants. The annual saving in energy supplied to the lamps amounts to $800 per year; if a higher energy rate had been chosen, the saving would have been greater in the ratio of the energy rates.

At 4000 hr. operation per year, 4 lamps per outlet are required, and the annual saving in lamp renewals amounts to about $990. This saving is almost directly proportional to the hours of operation, assuming that the life of the 230-v. lamps will be fully equal to that of 115-v. lamps. Although 230 and 115-v. lamps are given the same life rating, the service performance of 230-v. lamps may be expected to be less consistent than that of 115-v. lamps. The higher voltage lamps cannot be made so rugged as 115-v. lamps because of the smaller diameter and the greater length of the filament, nor are they so well able to withstand unfavorable voltage conditions.

By adding the annual saving in fixed costs, the annual saving in energy, and the annual saving in lamp renewals, it is seen that the total annual saving in the use of lamps of the 110-125-v. class amounts to $1878.

It is probable that a plant of the size here discussed would generate alternating current, in which case the installation of a transformer or a small balancer coil would provide the proper voltage for the lighting circuits at small expense. If direct current were generated, a three-wire generator would probably be used to furnish both maximum motor speed control and proper lighting circuit voltage. If a straight two-wire direct-current generator were used, a balancer set, which for this installation could be obtained for approximately $660, would pay for itself in about four months. Looking at it another way, the balancer would effect a saving of nearly $1900 a year on lamps and their equipment, although costing only about $200 a year to operate, including interest on investment, depreciation, taxes, and energy losses.

Existing 220-250-V. Installations

In the case of existing 220-250-v. installations where the outlets are properly placed and where the proper reflector equipment is used, the problem becomes one of determining whether the superior lamp performance, the saving in lamp replacements, and the advantages of increased illumination will make profitable the investment in, and the operation of, a balancer, and the additional investment in wiring.

Table III has been prepared to simplify the calculation of possible saving under the condition of simple replacement watt for watt of 220-250-v. lamps with 110-125-v. lamps. In this table, the difference in price between lamps of these voltage classes has been calculated under various contract discounts. Whether or not the installation of a balancer set, in addition to providing better lamp service, will result in actual money saving may be quickly determined by obtaining from this table the difference in lamp price under the given contract conditions, multiplying this difference by the number of lamps used in a year, and comparing this with the yearly cost of the balancer installation.

If, for example, the problem is one of converting a 230-v. direct-current system operating 4000 hr. per year and employing, say, 4000 60-w. 230-v. lamps to one for 115-v. units, the following results will be obtained:

By reference to the column showing the difference in price of 60-w. lamps when purchased on, say, a $2500 contract, it is found that each 115-v. lamp is cheaper by $0.0639. Since there are 4000 outlets and since four lamps will be required for each outlet per year of 4000 hr. yearly operation, the total annual difference in the cost of the lamps is in excess of $1000. A 288-amp. balancer set, costing about $1100, should take care of any unbalancing which would normally occur in such a system. Interest at 6 per cent, taxes at 1 per cent, and depreciation at 7 per cent on the balancer would amount to about $154, and the cost of energy, at 1 cent per kilowatt-hour, for operating the balancer would amount to, say, $176 more, assuming that it operated at 50 per cent load for the full 4000 hr. Thus the yearly cost of the balancer would, in this case, be approximately ⅓ of the yearly saving in lamp renewals. If the lighting system were in use less than 4000 hr. per year, or if the cost of energy were higher, the saving would not be so large, but would, in the majority of cases, be amply sufficient to make the installation of the balancer profitable. On the other hand, if it were in use more than 4000 hr. per year, the advantage would be greater. In the case of alternating-current circuits, the cost of a balancer coil is so low that its installation will prove profitable under almost any conditions.

TABLE III. DIFFERENCE IN COST OF 110-125-V. AND 220-250-V. LAMPS WHEN LAMPS ARE PURCHASED ON CONTRACT

	Lamp Size in Watts	Difference in Cost on Purchase Basis of:								
		List	Std. Pkg. Quantity	$150 Contract	$300 Contract	$600 Contract	$1200 Contract	$2500 Contract	$5000 Contract	$10000 Contract
Mazda B	25	$0.0600	$0.0540	$0.0498	$0.0474	$0.0456	$0.0438	$0.0426	$0.0414	$0.0402
	40	0.0600	0.0540	0.0498	0.0474	0.0456	0.0438	0.0426	0.0414	0.0402
	60	0.0900	0.0810	0.0747	0.0711	0.0684	0.0657	0.0639	0.0621	0.0603
	100	0.1500	0.1350	0.1245	0.1185	0.1140	0.1095	0.1065	0.1035	0.1005
Mazda C	200	0.2000	0.1800	0.1660	0.1580	0.1520	0.1460	0.1420	0.1380	0.1340
	300	0.6000	0.5400	0.4980	0.4740	0.4560	0.4380	0.4260	0.4140	0.4020
	400	0.8000	0.7200	0.6640	0.6320	0.6080	0.5840	0.5680	0.5520	0.5360
	500	0.9000	0.8100	0.7470	0.7110	0.6840	0.6570	0.6390	0.6210	0.6030
	750	1.2000	1.0800	0.9960	0.9480	0.9120	0.8760	0.8520	0.8280	0.8040
	1000	1.4000	1.2600	1.1620	1.1060	1.0640	1.0220	0.9940	0.9660	0.9380

Those who are responsible for production in an industrial organization find that improvements in illumination, although obtainable at small expense, are accompanied by gratifying improvements in the quantity and quality of the product and in increased safety and comfort of employes. For this reason, the standard of illumination is rapidly rising. Where 2 yr. ago an intensity of four foot-candles would have been considered ample, today one of five, six, or more is demanded. How greatly

present-day intensities may be increased efficiently is not known, but the fact is definitely established that illumination intensities commonly employed are well below the economic limit. The substitution of 115-v. lamps for 230-v. lamps in the case of the example at hand presents an opportunity for increasing the illumination by more than 10 per cent. In practically every case, the money equivalent of the improvement in production, safety, and spirit of the operatives is greater than the money which might be gained by decreasing the cost of illumination by this percentage.

Cost of Making Holes in Switchboards

By John D. Morgan

IN every switchboard panel installation it is necessary to drill, slot or counterbore many holes in order to facilitate the installation of the various instruments mounted on the panel, yet very few engineers, when estimating or appraising the cost of panels, give due weight to the actual drilling costs, for the majority have not considered it a major cost; yet if one is required to give a close estimate or appraised value, this cost must be taken into consideration. Below is given a table of drilling costs; this table is the result of a very

DRILLING COSTS

Size of Hole in.	Cost per Hole	Size of Hole in.	Cost per Hole
1/8	$0.05	1-7/16	$0.26
3/16	0.06	1-1/2	0.27
1/4	0.07	1-9/16	0.28
5/16	0.08	1-5/8	0.29
3/8	0.09	1-11/16	0.30
7/16	0.10	1-3/4	0.31
1/2	0.11	1-13/16	0.32
9/16	0.12	1-7/8	0.33
5/8	0.13	1-15/16	0.34
11/16	0.14	2	0.35
3/4	0.15	2-1/4	0.36
13/16	0.16	2-1/2	0.37
7/8	0.17	2-3/4	0.38
15/16	0.18	3	0.39
1	0.19	3-1/2	0.41
1-1/8	0.21	4	0.43
1-3/16	0.22	4-1/2	0.45
1-1/4	0.23	5	0.47
1-5/16	0.24	5-1/2	0.49
1-3/8	0.25	6	0.51

Size of Slot	Cost per Slot	Size of Counterbore	Cost per Counterbore
1-1/2 x 1	$0.50	1/8 x 5/16	$0.02
2-1/2 x 1/2	0.60	7/32 x 1/2	0.03
2-7/8 x 1	0.75	1/4 x 5/8	0.03
4 x 1-3/4	0.95	9/32 x 5/16	0.03
4-3/16 x 1-3/4	1.00	9/32 x 5/8	0.03
5 x 2-5/8	1.00	5/16 x 1/4	0.04
5 x 3-3/4	1.00	3/8 x 1/4	0.04
5-1/4 x 2-3/4	1.00	5/8 x 1	0.06
6-3/16 x 1-3/4	1.00	3/4 x 5/8	0.07
7-1/2 x 6	1.20	3/4 x 7/8	0.07
7-5/8 x 2-3/4	1.00	1 x 1/8	0.05
10-15/16 x 3-3/4	1.00	1 x 5/32	0.06
12-1/4 x 4-1/8	1.20	1 x 1/2	0.05
15-3/8 x 4-1/4	1.30	1-1/16 x 3/8	0.07
		1-1/4 x 3/4	0.11
		1-1/2 x 5/16	0.12
		3 x 5/8	0.16

thorough study of time used in drilling and setting up. These costs are only for shop drilling and one devoid of overhead and depreciation, or, in other words, they are the actual shop labor cost. Owing to the great diversity factor of field erection, field drilling costs cannot be tabulated in such a manner; yet a very close approximate field drilling cost would be about twice the costs given. This table was made up using 2-in. slate as a base.

Receiver Explosions

By Letson Balliet

THE explosion of receivers in compressed air lines and the conduits for compressed air has caused considerable comment in the newspapers. Invariably the non-technical publishers attribute the cause of these explosions to the failure of the safety valve.

While the safety valve is an excellent thing to have upon an air receiver, in case of over-pressure and particularly for the moral effect that it has upon the workmen in the vicinity of it, it is well to know that if the air receiver was equipped with a hundred safety valves, all in working order, they would not prevent the explosion if the conditions inside the receiver were right; in fact, the conditions inside the air receiver cause the same result that 50 lb. of dynamite would cause in the same receiver. It must be borne in mind that air receiver explosions are seldom, if ever, caused by excessive pneumatic pressure, but, on the other hand, they are really the explosions of highly combustible oil-gases and vapors pumped into the receiver from the compressor. It is almost impossible to supply lubrication to a compressor in sufficiently small amounts that some oil-gases will not be carried into the receiver and conduits.

Air compressing is the reverse operation of the steam engine. With steam, the pressure is built up in an enclosed boiler, conducted into the cylinders of an engine where it expands, giving off power or energy, and is then exhausted into the atmosphere. The lubricators of a steam engine can safely use almost any amount of oil because it is exhausted into the open air. The air compressor receives its air at atmospheric pressure; power is applied to the pistons for the purpose of compressing it, to be exhausted into an enclosed receiver. Every bit of lubrication fed into the cylinders of an air compressor must eventually pass into the receiver.

It is well to call attention to the fact that the cylinders of an air compressor are not subject to the scouring action that the steam cylinders of an engine are, hence it needs less lubrication in the first place.

Frequently engineers adjust the lubricators for the steam-end and the air-end of the compressor alike, and sometimes when automatic governors control the speed of the compressor the lubricators feed the same amount of oil per minute at slow speed that they feed at high speed.

There is, or should be, always an attempt to use lubricating oils that are low in carbon, but no matter what method of lubrication is used it may always be put down as a fact that more or less oil-gas and oil-vapor from lubricating oils is pumped into the air receiver. This is combined with more or less dust gathered from the air, some of which settles in a thick, viscous scum upon the inside of the receiver shell, while some of it passes off in gas through the conduits and tools. In fact, I have known men in poorly ventilated mines to be overcome from oil gases that come from the exhaust of rock drills.

The passing of a carbon spark, that may have become ignited with the heat of compression or friction, into the air-receiver might, and probably does, cause

the ignition of the oil gas within the receiver, which results in a violent explosion.

Another point which I wish to make in this article is that all lubricating oils used in compressors are marked with a supposed flashing test to indicate the temperature at which the oil will flash, but these tests have all been made at atmospheric pressure, a condition which does not exist in the inside of an air-receiver, nor does the test indicate at what temperature the flash will occur when the lubricating oil has been broken down into a gas.

In line with this thought, I wish to call your attention to the fact that a candle taken down into a caisson, where the operations are conducted under two or three atmospheres, will burn with a much more brilliant flame than the same candle will burn at atmospheric pressure; in other words, the combustion is much more rapid under pressure than at atmospheric pressure, and conversely, a candle taken up to the top of a high mountain will burn with a very sickly, weak flame. This point in combustion is one of the examples cited in our elementary physics, and yet it seems to have been ignored in the study of air receiver explosions due to lubricating oils. Therefore, I am satisfied to say the combustion of lubricating oil and oil-gas must be more violent and rapid under pressure of eight or more atmospheres than at atmospheric pressure, and I am forced to believe that the so-called flash point of liquid lubricating oil at atmospheric pressure is of little value because it does not give the point at which the oil-gas will flash under pressure.

My deductions from the foregoing studies are that the air receiver should be supplied with a manhead and that it should be opened and thoroughly cleaned of the oil and dust that accumulate on the inside of the shell; that it should be frequently drained, and the lubrication of the compressor reduced to the minimum, and it is probably needless to add that the best grades of oil should always be used in the compressor cylinder.

A Diesel Engine Marine Installation

FOR propulsion of the Manteo, a dredge tender built for the United States Government and having an overall length of 50 ft., 13-ft. beams and 6 ft. 6 in. depth of hull, there has been built by the Fulton Mfg. Co. of Erie, Pa., a 4-cycle, 6-cylinder oil engine of the straight Diesel type. The cylinders are 8 by 9 in., and the engine turns 400 r.p.m., developing 100 b.hp.

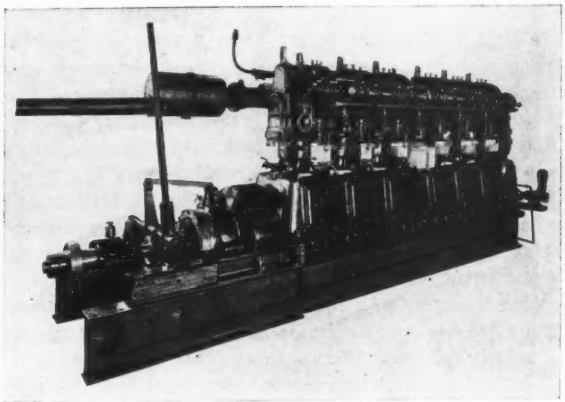
As shown in the photograph a 2-stage air compressor is situated on the forward end of the crank case; the air from this is led through a water-jacketed pipe to three steel air bottles tested to a pressure of 3000 lb. The air in one of these bottles is used for the injection purposes. The compressor compresses more air than is required for running, the surplus being stored in the 2 steel bottles used for starting only.

On the starboard side of the engine are the individual fuel pumps, one for each cylinder; these are made out of blocks of steel, and as there is an individual pump for each cylinder, if by any chance one of the pumps or one of the cylinders should go wrong while the boat is at sea, the operator could cut out the defective cylinder and continue running on the others.

Lubrication of pistons and cylinder walls is by means of a Bosch oiler, with two leads to each cylinder. Inside the forward end of the crank case are two rotating pumps; one of these drives the oil at a pressure up to 15 lb., if necessary, through the hollow crank shaft and up through the hollow connecting rods to the wrist-pin bearings; the oil oozes out on the bearing and drips back into the base. The base is water-cooled so that the oil is cooled and it then passes through a strainer and is returned to the pump. In this way, there is a steady flow of cool oil on the bearings.

Located beside the lubricating pump is another pump exactly similar to it which is used for pumping the fuel oil from the main tanks up to the gravity feed tank. These two pumps are in duplicate; if by any chance the lubricating pump should go wrong, all the operator need do is to connect up the lubricating system with the fuel oil pump and use that for lubricating the engine.

At the forward end of the engine may be seen the two heavy bronze plunger pumps for the water circulating and the bilge system. These pumps are also in



FULTON 100-HP. DIESEL ENGINE FOR PROPULSION OF THE MANTEO

duplicate, that should the water circulating pump go wrong when the boat is at sea the operator could merely connect up the bilge pump with the circulating water system and continue running.

Another interesting feature is that the flywheel, instead of being at the forward end, is at the after end of the engine; in this way, necessary strain is taken off the flywheel. Just back of the flywheel is a Paragon reverse gear.

The propeller is a threeblade type "I" Columbian propeller 42 in. in diameter by 38 in. thick, to turn 400 r.p.m. Extra heavy stuffing boxes are used on the propeller shaft weighing 195 lb. each. The bronze shaft is 3½ in. in diameter by 13 ft. long and weighs 492 lb.

A FIRM IN FRANCE desires agency for the sale of electrical and other machinery, and all articles salable to the metallurgical industry. Correspondence may be in English, and details may be had from the Bureau of Foreign and Domestic Commerce, Washington, D. C., referring to list No. 25,482.

Determining Furnace and Boiler Efficiency

CHART AND TABLES MAKE CALCULATIONS EASY AND RAPID. BY W. F. SCHAPHORST

THE importance of high grate, furnace and boiler efficiency is more keenly realized now than ever before. The advancing cost of coal is causing purchasers to stop and think a bit. They are wondering and pondering in this vein—"Now, what is the efficiency of my boiler? How much money could I save by improving my grate, furnace and boiler?"

Inasmuch as the grate, furnace and boiler are so closely allied—one dependent on the other—it is impossible to determine their efficiencies separately. The function of the grate is to hold the coal in such a way that the air can mingle with the coal to best advantage. That the grate plays a highly important role in combustion has been proved time and again. Plain grates have been removed, for example, and the more modern type substituted and savings have invariably been effected.

The same is true in the furnace. Modern methods prove that combustion is far from perfect in many a furnace of today. Various manufacturers have various methods of perfecting combustion, but in general the principles are all the same. It is not the writer's object to discuss "method" here, but rather to stimulate interest in the possibilities of higher efficiency.

And as for the boiler, nobody doubts that there are good boilers and bad boilers, and the consensus of engineering opinion is that the modern boiler is the most efficient of them all.

Very frequently, nowadays, we read about "a new boiler efficiency record." Of course, this record means the "combined boiler, furnace and grate efficiency."

The writer has heard complaints about the difficulty of computing this efficiency. Unless one has a textbook handy and unless one has had a college education, it is well-nigh impossible to go through the gymnastics of the mathematical end of it.

To alleviate these sufferings, the writer has, therefore, prepared the chart printed in the Reference Tables of this issue, and the directions below have been made as clear and simple as possible. Simply lay a straightedge across the chart four times, in order shown on the dotted lines—1, 2, 3, 4—and the combined grate, furnace and boiler efficiency is immediately found in column F.

For example, let us assume that you are now burning coal having a heat value of 12,000 B.t.u. per pound when dry. As fired, however, the coal contains 5 per cent moisture. By means of line No. 1 connect the 12,000 (column A) with the 5 (column D) and locate the intersection with column BC, as I have indicated by means of the small dotted circle.

Next, you find that 2000 lb. of that coal, as fired, evaporates 16,000 lb. of water into steam, the steam pressure being 130 lb. per square inch absolute. The temperature of the feed water is 100 deg. F.

Connect the 2000 (column B) with the 16,000 (column E) and locate the intersection with column F (see line No. 2).

Now, in Table I, on the back of the chart, find the value of H opposite 130 lb. absolute pressure. You will find it to be 1187.8. Next, in Table II, find the value of h opposite 100 deg. feed water temperature. You will find it to be 68.01.

Subtract h from H and we have $1187.8 - 68.01 = 1119.79$.

Now locate 1119.79 as closely as possible in column C and connect by means of line No. 3 with the intersection already located in column F. Thus we locate the intersection in column DE marked with a dotted circle.

Lastly, by means of line No. 4, connect the intersections thus located in columns BC and DE and the intersection with column F gives the answer—79 per cent.

By following this selfsame method the efficiency of any ordinary installation can be closely determined for, as will be noted, the efficiencies shown, column F, range all the way from 20 to 100 per cent.

This chart is also applicable to other fuels, such as oil or wood except that correction would have to be made for oil of 20,000 B.t.u. heat value because that value is not given in column A. We can use 10,000 instead and make corresponding corrections elsewhere.

In instances where the weight of coal as fired is greater or less than values given in column B it is a simple matter to multiply or divide in such a way that the chart will be applicable. For example, if 60,000 lb. of coal were fired and 600,000 lb. of water evaporated, simply divide each by 2 and we have 30,000 (column B) and 300,000 (column E). As constructed, though, the chart applies to most problems met in everyday practice.

Five Ways to Save Coal

BUSINESS MEN throughout the country are urged by the National Chamber of Commerce to help reduce coal requirements by getting full heat value out of fuel and using supplies which are nearest. The following five suggestions are made:

1. Inquire into the methods employed by your fireman and consider his methods in relation to those suggested by the Bureau of Mines.
2. Learn what plants in your locality secure the best results from coal.
3. Endeavor to have the wasteful users of coal profit by the best experience of the locality.
4. Improve all local methods by consultation with the Bureau of Mines and study of the stoking methods recommended by the bureau.
5. Buy your coal as near home as possible.

OPPORTUNITIES for foreign trade of interest to power plant manufacturers, as given in the consular and trade reports of the Bureau of Foreign and Domestic Commerce, Washington, D. C., are as follows:

A commission merchant in Spain wishes to secure an agency for the sale of refrigerating machinery. Correspondence should be in Spanish. The number on the Bureau's list is 25,461.

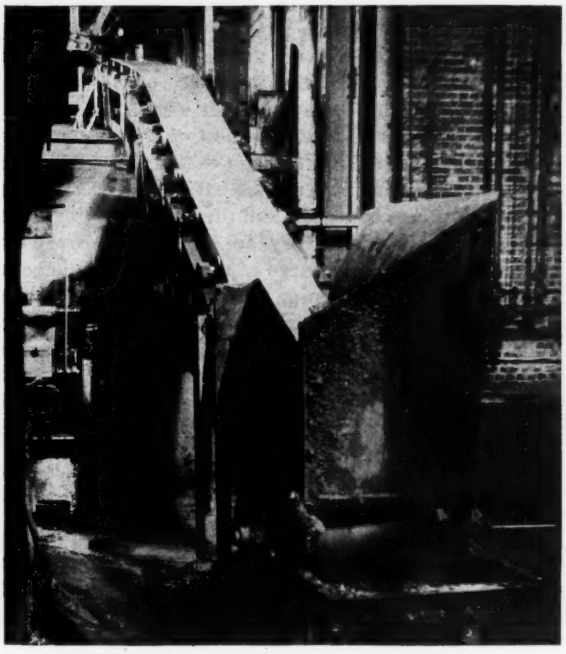
A company in Italy wishes to purchase electric motors and dynamos of not less than 200 kw. capacity, especially those of 500 or 600 kw. Correspondence should be in French or Italian. The Bureau's list number is 25,474. Further information can be obtained by writing to the Bureau of Foreign and Domestic Commerce, in care of Department of Commerce, Washington, D. C.

Makeshift Coal Conveyor

ENGINEERS are repeatedly called upon to place in operation some device which will enable them to "keep things going."

Two 750-hp. B. & W. boilers with Model stokers were recently installed in an addition to the boiler room of the Erie Lighting Co., at Erie, Pa. Owing to the present difficulty in securing shipments, an extension of the present coal conveyor system to serve the new boilers could not be promised until a distant date.

To make the best of the situation, a temporary belt conveyor has been erected which rises over the dutch-oven type stokers as shown in the accompanying view. The frame is constructed of 2-in. angle iron upon which a number of wooden spools were mounted to support an 18-in. conveyor belt. Placed on a temporary platform at the other end of the conveyor is a 5-hp. induction motor which drives the conveyor, a speed reduction being secured through a small set of belt-drives.



SUPPLYING COAL TO STOKER HOPPERS IN EMERGENCY

Coal is delivered by the regular coal conveyor system to a supply bin on the boiler room floor from which it is shoveled when required onto the belt. It is shunted from the belt at either of the stoker hoppers by lowering a V-shaped wooden tripper mounted on an arch which is attached to the conveyor frame.

WHERE THE EXPENSE of a steam trap for receiving condensate which can be thrown away is prohibitive, it is recommended that the discharge pipe be extended outside the building and its open end buried a few inches below the surface of the ground. The resistance of the earth will be sufficient to prevent the free passage of steam into the atmosphere and yet afford ample drainage. —Electrical World.

The Second Liberty Loan

ALL America, every man, woman and child, has a vital interest in seeing and helping the new National Army become the best in the world and in having it win this war for the safety of free, civilized peoples. But without money the army cannot win, and unless the Liberty Loan succeeds, America will have lost the war before ever a shot is fired from her guns.

Success for this second loan is as important as it was for the first. And every person who subscribes to a bond not only lends his money to the Government at a good rate of interest on gilt edged security, but at the same time contributes to the welfare of the army and the success of the war for liberty.

Marvelous work is being done in the erection of cantonments for this army. Sixteen of these cities, each to accommodate 40,000 men, are going up at unheard-of speed. Here a barracks, 34 by 140 ft. and 2 stories high is built in 1.5 hr.; there carloads of roofing tacks are arriving; yonder is an auditorium to seat 3500 men; joining all are 60 miles of roadway under construction; water, light and power plants are being rushed to completion; everywhere is hustle and progress.

And these soldier boys of ours are to have the best of care; clean quarters, good food, baths, exercise, amusements, hospital care; they are safer from sickness in an army camp than at home in the city or on the farm.

But all this costs; it costs a lot. The expense in a few weeks has been $150,000,000—more than was spent in 3 yr. on the Panama Canal. And this takes no account of clothing, rifles, ammunition, transportation, artillery, airplanes, trucks—all the thousands of things needed for successful carrying on of the war.

Billions of dollars are needed, and more billions. But our young men, the best possession we have, are going forth to fight our battles, to risk their lives in order to save our friends and our country from dishonor, our wives and daughters from a future fate such as has come to the women of Belgium.

Are we to grudge our dollars to back them up?

Many cannot go to the firing line. Age, responsibilities, physical condition prevent, and industries demand their activity at home. But all can save and invest with Uncle Sam according to their means. Back of the Liberty Bonds are the whole resources of this nation, the best guarantee in the world that they will be paid when due. There will always be a ready market, so that they can be sold if the money is needed. Buying these bonds is an investment approved by every bit of our common sense.

But more than that—it is a duty of every citizen who is loyal to his country in this crucial period. A man who is not doing his best to assist the Government is practically helping the enemy. If he has bought bonds of the first loan, it is now time to buy of the second. If he missed in helping on the first loan, now is the time to remedy that slip—to invest every dollar he can spare to back Uncle Sam and our boys—our brave, earnest boys—in their work and sacrifice.

WHEN A man has to have legal advice as to whether what he wants to say is treason or not, he better not say it anyway.—THE SEARCHLIGHT.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Providing Handholes for Centrifugal Pump

THE CIRCULATING PUMP to our surface condenser is of the horizontal centrifugal, double-suction, steam-engine-driven type, with a capacity of 12,000 gal. per minute when running at a speed of 164 r.p.m. After the pump had been in use for a while, it was found that the nozzles in the impeller were getting clogged with blocks of wood and rubbish, and as the casing of the pump is not one of the split type, it became a question as to how the nozzles were to be cleaned.

The only solution appeared to be the removal of the sides or ends of the pump casing, and after removing the nuts from 36 7/8-in. bolts and disconnecting the suction line, the outboard end of the casing was moved sufficiently far to allow one to remove the rubbish from the nozzles on that side of the impeller. But when it came to removing the other end of the casing it was a different proposition. As will be noticed in Fig. 1,

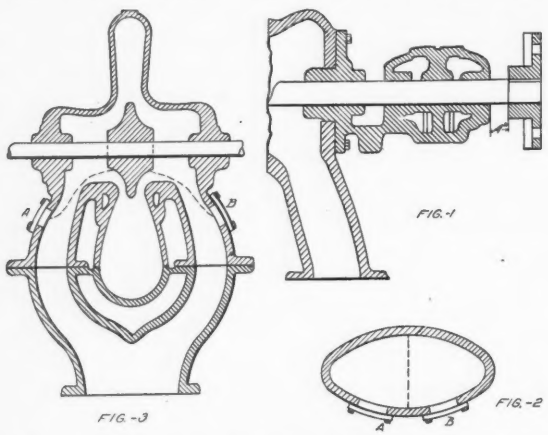


FIG. 1. LIMITED SPACE PREVENTED REMOVAL OF THIS SIDE OF CASING

FIG. 2. DOTTED LINE SHOWING WEB ACROSS SUCTION PIPE; A AND B INDICATE WHERE HOLES WERE CUT

FIG. 3. HANDHOLE PLATES AT A AND B

there is a space of only about 4 in. between the shaft bearing and the coupling on the crank shaft of the engine, and for this reason it was impossible to remove that end of the casing far enough to reach the impeller nozzles. The only solution appeared to be to uncouple the shaft and move either the pump or engine, or dismantle the pump altogether.

The thought occurred to the writer that it might be possible, by cutting handholes in the suction lines, close up to the shaft, to reach the impeller.

As the suctions are of elliptical shape there is a surface about 18 in. long by 10 in. wide on the face between the flange on the suction and the shaft bearing. It was the intention to cut one handhole in the face of each suction line; but it was found that there was a web across the inside center, as shown by the dotted line in Fig. 2, and for this reason two holes, about 5 by 6 in. square were cut in each suction pipe, one on each side of the web.

The suction pipes are about 1¼ in. thick and the handholes were cut by drilling a row of small holes with an electric drill and cutting between them with a cold chisel.

These handholes proved to be the solution of our problem, for it is now an easy matter to reach the impeller, as shown by dotted lines in Fig. 3, and remove any sticks or dirt that may collect there. Any pieces that get caught in the discharge end of the nozzles are removed by crawling into the discharge pipe, through the water box on the condenser, and pushing them down into the suction side where they are removed through the handholes. As the discharge pipe is 20 in. in diameter, a person can enter the pipe without any inconvenience.

The cover plates for the handholes were made of ¼-in. steel plate, easily bent to conform to the curvature of the pipe, and are held in place with stud bolts. One piece of plate is cut large enough to cover both holes on one suction, and a piece of sheet packing underneath makes a tight joint.

There is no reason why these handholes could not be made when the pump was built, which would certainly have been a great improvement, for it is beyond the writer's imagination to understand how a builder or designer could ever expect the impeller nozzles to be cleaned if once they became clogged up.

E. C. WELLS.

Engine Accident

C. M.'S LETTER on page 708 of the Sept. 1 issue of Power Plant Engineering, describing a possible accident which was avoided, reminds me of a somewhat similar one which was not. A 15 by 15-in. 4-valve engine of the nonreleasing type, running at 230 r.p.m., had its exhaust connected with the heating system of a nearby building, but as the engine was used only as a standby, the back-pressure valve had been removed from the atmospheric exhaust, the gate valve connecting it with heating system was closed, and a drain provided for the line.

After starting up one day, the engineer heard a sharp clicking sound and not being able to locate it, he closed the throttle, whereupon the engine came up with a bang; water squirted from under the cylinder head in a sheet. The cylinder was equipped with relief valves and these, no doubt, saved the cylinder head from being

blown off. As it was, the threads were stripped on the crosshead end of the piston rod and the crank disk key was sheared about 3/16 in. A new piston rod was necessary, and as it was found impossible to remove the crank disk, the old key was drilled out and a new one fitted.

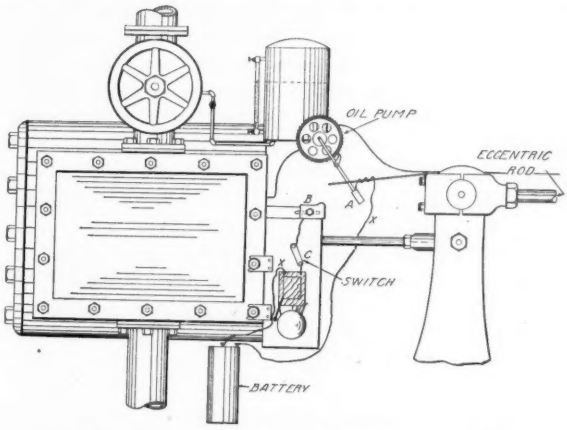
The trouble had been caused by the exhaust pipe drain having been stopped up, thus permitting the line to fill with water either through a leaky throttle or a defective gate valve connecting the heating system. In any case, when steam was shut off the engine acted as a pump and drew a quantity of water into the cylinder.

A. C. McHugh.

A Novel Engine Alarm

On account of the heavy overloads which frequently came onto a high-speed direct-connected generating set of which I once had charge, the circuit breaker would open just as frequently, necessitating considerable watchfulness and resulting in much inconvenience. To eliminate this trouble I devised and constructed an automatic electric alarm as illustrated herewith and which if properly adjusted would operate with a steam drop of 2 lb. or a load increase of 5 amp., although I do not as a rule adjust it for such close work.

At A is a copper contactor receiving its motion from the valve rocker arm and connected electrically to one terminal of a battery. Another adjustable contact is fixed to the steam chest cover at B and is connected electrically to the other battery terminal; a switch, C,



ARRANGEMENT OF ALARM BY MEANS OF WHICH OPERATOR IS NOTIFIED OF LOW STEAM PRESSURES AND INCREASED LEADS

is employed to throw this device into and out of operation.

The following, I believe, will readily explain how this arrangement works: With a shaft governor we know that the valve travel increases with heavy loads and decreases with light loads. With the engine carrying an average load, I adjust contact B until it is just ready to touch contact A. If, now, the steam pressure drops or the load increases, the valve travel will increase, causing A to come into actual contact with B, completing the circuit and ringing the alarm.

A. C. Waldron.

Cleaning Tubular Boilers

On page 744 of the Sept. 15 issue, I notice an article by H. A. Jahnke with reference to cleaning return tubular boilers. Mr. Jahnke does not seem to consider the boiler tube cleaner method of cleaning return tubular boilers. Perhaps he is not familiar with the work of the Lagonda vibrator cleaner which operates inside the tube as an ordinary water tube cleaner, but which is equipped with a special clover leaf vibrator head, and by means of vibration completely removes the scale from the outside of the tube. This method, in my experience, is most satisfactory.

C. W. Kalbfus.

The Brickmason's Wrong Idea and the Trouble It Caused

Steam for running an ice-making and cold-storage plant in a village some miles distant from our town is supplied by two water-tube boilers of about 150 hp. each. In building this plant, the owners started with a determination to put in an equipment of top-notch quality throughout, both in material and design, and adjusted in accordance with the best engineering practice. They were bent on fixing up an outfit that could be depended upon to run without hitch or babble, but in one very important particular their plans went awry. They had entrusted the work of building the boiler masonry to a man more competent to turn out a neat-looking job than one in exact conformity with the rules of scientific furnace construction, and therein lay their misfortune.

The plant was started in March and was run through to the following November, when it was shut down for the winter—the two boilers having been continuously in service during the interval. Toward the close of the season, the furnace draft didn't seem to be quite as good as it was during the early months of the run, although as a matter of fact the draft wasn't anything to get enthusiastic about, even at the beginning of operations, notwithstanding the stack was certainly tall enough and everything else appeared about right. But as the accumulations of ash in the combustion chambers were banked up almost to the tubes, the folks attributed the weakening of the draft during the closing months solely to this fact, and let it go at that; however, the combustion chambers were thoroughly cleaned out.

When they started again the next spring, the draft seemed to have improved a trifle, but still it was far from satisfactory. They ran along until August, with the steaming conditions going steadily from bad to worse and thence onward to simply abominable and utterly deplorable. Proper running of the plant required a gage pressure of 110 lb.; but they couldn't get more than 85 lb., and had to slow the engine down every little while to hold even that pressure. With the flame backfiring through the fire-doors, and the heat radiating from the cast-iron fronts, and the atmosphere surcharged with smoke and coal-gas, the work of stoking those furnaces became downright punishment, and they had a hard time holding men on the job. The draft gage showed no measurable draft at all. Still it was imperative that the plant be kept going somehow until shutting-down time came in the fall. Someone suggested the idea of blowing air into the ashpits. So they sent for a man who specialized in this sort of thing, and the man

said he'd fix 'em up a nice draft. The blower he put in was an excellent piece of apparatus and was connected up in regulation style, but he might just as well have blown his breath in there for all the good it did.

The plant was due for a shut-down in November; but the worry of it all finally got to rasping the nerves of the folks so grievously that they concluded to drop out some three weeks ahead of the regular schedule. Things had reached a stage where it was simply impossible to make enough steam to keep the outfit going longer than an hour at a time, and the whole wretched business was losing money for them.

About this time, they hired a new engineer. When the settings were cool enough, the engineer set a couple of men at work cleaning out the combustion chambers, and then he went in to take a look. One look was enough. It told the whole story. The boilers were baffled lengthwise of the tubes; the first baffle being formed of box-tiling that completely enclosed the tubes in the bottom row. This baffle extended right along to within 10 in. of the back waterleg. That was the cause of it all—that 10-in. pass around the end of the lower baffle. The pass should have been at least 48 in. The tubes had been blown very diligently, with steam, through the hollow staybolts in the front waterleg, and those frequent blowings with moisture-laden steam had resulted in clogging the spaces between the portions of the tubes immediately above the 10-in. opening at the back end with caked soot and fly-ash.

The only apparent reason why the man who set the boilers hadn't run the baffles clear back to the waterlegs was because the tiles were of 10-in. length, and, therefore, he had to have at least this much clearance in order to slip them around the tubes. The 10 in. he left bare was the clearance that allowed him to slip in the last lateral row, and as he couldn't figure out a way to put in another row, he no doubt concluded to leave the vacant space and say nothing about it. A. J. Dixon.

Oiling the Engineer

This is a practice that is rapidly slipping away, as it justly should. The method of selling engine and boiler room supplies by enriching the engineer with a gift of $5, $50, or even $100, is not a moral method. The man who has to "buy the buyer" cannot sell goods of as high quality as can the man who does a "straight" business.

These gifts were excused in days gone by as "expressions of appreciation" or "friendship gifts" from the salesman to the buyer; but at the same time, both knew well that if a competing salesman would offer a higher cash reward the competitor would get the business. Neither the salesman nor the buyer had a clear conscience, and as long as one's conscience creaks you can be sure there is something wrong in the business method. The proper kind of business, always, is the one that can be done entirely in the open, with all figures and materials exposed, leaving a clear conscience.

An old and experienced salesman told me yesterday of a large institution whose former engineer was known far and wide as one who needed liberal "oiling." It was the belief of this engineer that by looking after the interests of "No. 1" first he was bound to come out ahead. As a result, the materials he purchased were not the best. The manufacturers of the leading products could not undersell those who were liberal with gifts of gold pieces and they refused to stoop to questionable practices. The efficiency of the engineer's plant, therefore, was never improved, but on the contrary became worse.

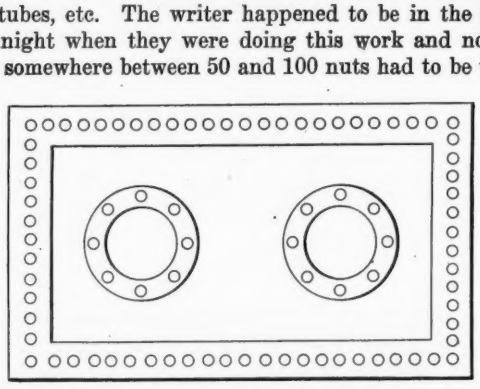
After a time, the owners realized that there was "something wrong somewhere" and they investigated. They wondered why "such and such a thing" wasn't used "there and there," and the only explanation the engineer could give was that he got the substitute at a lower price. However, investigations of the right kind don't merely feel around on the surface. The owners got down under the surface and learned of a few of the various "oilings" the engineer had received, and in a short time they saw fit to bid the engineer goodbye.

The new engineer in this institution has virtually rebuilt the power plant from top to bottom. He is absolutely straightforward in his methods and he finds that it pays him well, for his yearly salary is not only in the four figures—it runs into the five figures. The owners state that they can afford to pay an honest engineer a good salary because if he is even halfway honest, he can save more than that for them in 6 mo.

N. G. Near.

Saving Time and Labor in Inspecting Condenser

In a small backwoods plant which the writer once visited on some engine repair work, it was noted that they had constant trouble from a small condenser which they had in service because of clogging, due to dirty circulating water. The condenser, being an old one, was constantly developing leaks in the tube end plates. These troubles kept the force at the plant many nights, taking off the condenser heads to clean out the dirt and inspect the tubes, etc. The writer happened to be in the plant one night when they were doing this work and noticed that somewhere between 50 and 100 nuts had to be taken



CONDENSER HEAD PROVIDED WITH HANDHOLES

off to remove the condenser heads. Since it was not always necessary to remove the entire head. I suggested that they place a handhole or two in the condenser head and secure the desired result by handling only 5 or 6 nuts instead of taking off the entire head each time. In accordance with this suggestion, two 6-in. handhole plates were tapped into the end of the condenser head as shown and are doubtless now being used by the force with a saving of an hour or so in time and as much labor every time the unit has to be inspected.

M. A. Saller.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Can You Tell Him?

I HAVE under my care an old Corliss engine of the crab-claw type. The marks on the hubs of the wristplate for use in setting the valves have been changed by someone, making it practically impossible for me to set the valves. Can some of the readers of Power Plant Engineering tell me how I may relocate these points?

E. B. P.

Who Will Be Responsible?

IN A MIDDLE WEST central station, the steam generating equipment consists of three horizontal return-tubular boilers the tubes of which are so thin that it would be possible to drive a hammer through them with but a few blows. Still, a pressure of 115 lb. gage is being carried.

When this condition became apparent, the insurance inspector notified the company that new tubes were required; but as no attention was given the matter, he finally had to resort to threats of cancellation of the policies.

This did also not have the desired effect and each time the inspector appealed to the company's officers to have the necessary repair work done, he was assured that upon his next call new tubes would be in the boilers installed.

For two years this went on, when finally, in order to protect his company, the inspector did have the policies cancelled. Of course, then new boilers were to be installed at once. But as yet, as far as the writer is aware, not a thing has been done to rectify matters and in view of the fact that the officers of the company are fully aware of the condition in which the boilers are, I wish to know who might be held responsible in the event of a serious accident. A tube rupture may at any time occur and do much property damage or, still more, scald or even kill one or more persons.

In a plant where such conditions exist, what should the engineer do? There are no state or local boiler inspection bureaus to compel the necessary repairs to be made.

R. B.

Eliminating the Rattle

IN ANSWERING G. R.'s inquiry as to some means of eliminating the noisy operation of his Corliss engine, I think a few words of explanation as to the cause of the slamming may be helpful.

Broadly speaking, a Corliss engine is not an ideal drive for a fluctuating load. If an automatic cutoff engine running under its normal load suddenly loses that load, the point of cutoff is shortened by the governor until the engine will, if the valves are tight, presently be taking no steam, and assuming that the load does not come on again at once, a vacuum will be formed in the cylinder; with a Corliss engine under these conditions, the atmospheric pressure in the exhaust pipe will tend to lift the exhaust valves with a disagreeable slam or clatter, and as wear takes place, this clatter increases. These, I take it, are conditions as they exist in G. R.'s plant.

It is in this case obvious that the proper thing to do would be to lengthen the point of cutoff, thus preventing the formation of the partial vacuum in the engine cylinder, and to this end the steam pressure must be lower, which is not always as easy a thing to do as it may appear at first sight.

In a case in my own experience, it was necessary to carry on our steam lines a constant pressure of 125 lb.; however, on this pressure we had a noisy engine, and by experiment I found that the best pressure for our engine was 70 lb. First we tried running our engine on a

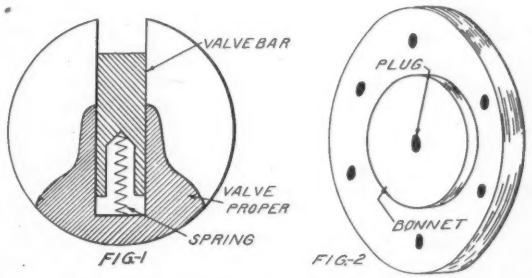


FIG. 1. SPRING IN EXHAUST VALVE TO PREVENT RATTLING
FIG. 2. PLUG IN VALVE BONNET PREVENTED RATTLING

separate boiler; but this proved uneconomical, so later we tried a reducing valve on the main steam line to the engine, getting better economy, but the most satisfactory results were obtained when we added 8 lb. back pressure to the engine and then raised the steam pressure.

Some engineers advocate running with the throttle partly closed as a possible remedy for a noisy valve gear; but I do not favor the idea, neither do I allow it to be done in my plant, as I have seen some serious shutdowns due to that very cause.

Still another method of eliminating the clatter is that of placing springs in the valve back, as illustrated in Fig. 1. Holes are drilled in the valve bar and small coil springs are placed in these holes bearing against the valve, as shown in the sketch. I have never seen this idea worked out, and personally question whether the

idea is practical; but I give it here for what it is worth.

Summed up, I should say lower your steam pressure and if possible increase your back pressure.

ARTHUR D. PALMER.

I HAVE HAD G. R.'s trouble. There are two things to do: Give the engine more load or lower the steam pressure; that will make the engine cut off later and the valve will work O.K. That is what I do, and before the load comes on again raise the steam back to normal.

FRANK WELLS.

THE FIRST THING for G. R. to do is to find just where the rattle is taking place. I would suggest that he might find that the valve disc on the valve stem of the throttle valve is loose and the variations of pressure at each time steam is admitted to the cylinder and the rapid velocity of the steam passing through the valve would keep this disc fluttering and rattling.

If G. R. had sent some of his indicator cards to Power Plant Engineer, I should have been able to tell him more about noisy valves, as I do not know just what he calls a fine card from his engine.

If he does not find the trouble in the throttle valve of his engine, as I have explained, it may be that he is running his compression pressure above that of the initial boiler pressure, which would cause the steam valves

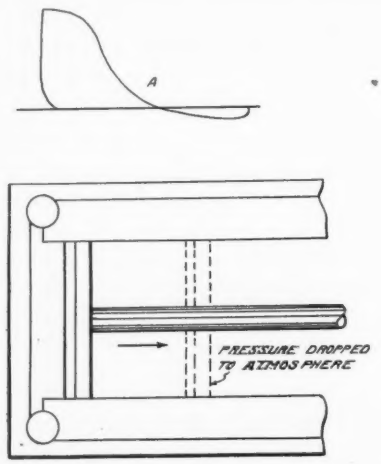


FIG. 3. DIAGRAM TO EXPLAIN RATTLE

to rise from their seats and fall back with a thumping sound.

There is another cause for G. R.'s trouble: That is, too early a cutoff which would allow the expansion line to drop below that of the exhaust line, atmospheric line, or pressure which the engine is exhausting against; if this pressure is great enough under the valve, there will be a lifting and slamming of the exhaust valves.

If G. R. will go over his engine carefully, he will likely find one or more of these causes present.

F. E. BACON.

I HAD the same trouble with a 16 by 30-in. Corliss engine, and overcame it as follows: I took off the rear valve bonnets, drilled a hole into the center and drove a brass plug into it and left it projecting out so it barely touched the valve, as shown in Fig. 2. I had no more trouble.

WM. FUNK.

I HAVE a 20 by 48-in. Watts-Campbell Corliss engine which had the steam ports rebored and new valves fitted. This gave trouble similar to that experienced by G. R. My first thought also was, "Is it getting proper lubrication?" so I ordered a force feed lubricator, in place of the old hydrostatic lubricator, and set it to run at its maximum capacity. If any difference, with more oil it seemed to make that much more noise and I had an idea that when turning off the steam at the throttle prior to shutting down, they would some day pop out of the engine.

One day, my fireman got into a lengthy discussion and let the steam drop from 100 to 62 lb. when the engine started to hang up and also to lose its rattle.

He finally got her moving up after putting wood in and shutting off the feed pumps; I kept my eye on the engine and it wasn't until it had reached 85 lb. that the rattle could be heard again. I cut it down to 75 lb. and it gives me no trouble at light loads and I can use the extra steam in heating and drying.

If G. R. will cut his steam pressure down to 75 or possibly 70 lb., I have not the slightest doubt he will also lose his rattle.

H. L. COLE.

IT IS QUITE POSSIBLE for the rattle of the valves to be caused from expanding below the atmosphere caused by carrying too high a steam pressure for the load, when the condition shown in Fig. 3 result.

The high initial for the light load results in cutoff occurring as shown by the piston's position, the steam expanding during the remainder of the stroke below the

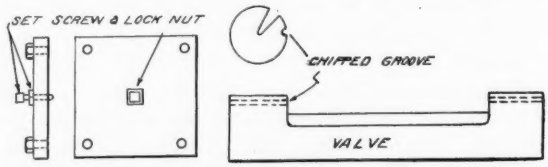


FIG. 4. TWO METHODS OF PREVENTING END PLAY

atmosphere as shown, so when the exhaust valve closes the pressure in the exhaust chest is greater than in the cylinder, so the valve is forced from its seat. When steam is admitted at this end, the higher pressure in the cylinder forces the valve to its seat with another pound.

In some constructions, springs of spiral shape are inserted between the valve and its stem which, when the valve is not a good fit in its port, will cause a rattle. To remedy this, increase the tension of the springs.

From the fact that G. R. gets good cards, it may be his trouble is due to the valves moving endwise in their ports. I have had this occur and have seen it overcome by drilling and tapping for a set screw in the valve bonnet to hold the valve at one end of the chamber.

The better way is to remove the valve and chip a groove, as in Fig. 4, in the valve head, thus admitting steam between the head and bonnet, equalizing pressure when the valve has no unbalanced pressure to move it lengthwise.

RECEIVER.

Is It the Fault ot the Indicator?

In the July 15 issue, C. J. M. brought out a few points on which I differ in opinion from him. First, he says, "Such deformations as the diagrams show may be produced by even the very best makes of instrument; no instrument should be condemned because of them."

If he means to state that an indicator is liable to go through a series of contortions once in awhile without cause in the usage of steam in the cylinder, then I must say I think C. J. M. is too liberal minded; for I certainly would call a machine absolutely worthless that would reel off a freak card whenever it was disposed to do so. You never could have any means of knowing when it was on its good behavior.

Also, he says, "The fault may be in the design of engine cylinder."

Since reading this I have been trying to form a cylinder in my mind, built to produce a card like that; however, I shall have to acknowledge I am not a designing engineer, as I cannot construct a cylinder to fill the bill.

Also, he says it may be in the valve setting, but he does not try to enlighten one on the subject and tell one how to overcome it by adjustments to valve gear. Regarding proper scale of springs to use for a given pressure, if we follow the rule sent with every indicator the results will be the best. I always figure upon using the lightest spring I can and be sure the indicator piston does not bring up against the stop, for the reason that the light spring gives the largest card, which card gives a clearer view to the workings of steam in the cylinder. If it were possible I should like to have an indicator that would reproduce the actions of steam in a cylinder in actual size, inch for inch. When you reduce anything from 1 ft. to 1 in., actual conditions cannot show up as they should.

I was using a spring scaling 14 lb. more than I should, as a 56 is good for 125 lb. and the 70 which I used 150 lb. and I wish to say C. J. M.'s practice, or advice, to use a heavy spring is, in my judgment, not correct, for it only handicaps the indicator, preventing it from showing up the trouble, thus making it hard to determine how the engine is working the steam.

C. J. M. was right in his analysis of the throttling governor engine diagram. Also, I agree that the Corliss valve action is a little late, but will that cause the hump in the steam line, which is the only point at issue? These engines are double ported and Card No. 3, in the Aug. 15 issue, will, I am sure, show C. J. M. that there is no restricted port opening.

The problem of the hump is still a mystery to me and I would appreciate further comments. E. C. D.

What Do You Think?

Commenting on the indicator cards shown by J. H. Case on page 748 of the Sept. 15 issue, in my opinion they show the crank end steam valve to be opening just a bit early, while the exhaust valve for this end closes much too soon, as the compression rises higher than the boiler pressure, as shown by the drop in pressure before the piston reaches the end of the stroke, making the exhaust valve for this end later. Reducing compression will take away the loop shown on crank end card. Release for the crank end will then occur somewhat earlier.

The head end steam valve apparently opens but very little, if at all, as the initial pressure in this end is only about ⅓ the boiler pressure; but this end does not show a negative loop as stated by Mr. Case, for if a negative loop were present the expansion and compression lines would cross and the cards do not show this to be the case. The head end card, however, does show that a partial vacuum exists in the exhaust pipe when the head end exhaust valve opens. This is signified by the fact that the exhaust line is below atmosphere for about ¾ of the stroke.

In general, to correct the faults shown I would make the crank end exhaust close later and the one for the head end a little earlier. I would leave the crank end steam valve as it is, but would make the one on the head end open earlier. It would be interesting to see a set of cards after the changes were made with an account of what was done to correct the faults. C. B. H.

In reply to J. H. Case's invitation to tell how to correct the card from his Ridgway engine, only general suggestions are given.

First, the lengths of the eccentric rods would be made such as to cause the rocker arms and valve levers in the gear case to move equal on each side of their supports. In some non-releasing gears the valve stems are clamped to the moving crank arms, while in other designs they are keyed.

Measure the length of the governor springs and loosen them up to enable the governor to be easily moved into its extreme outward position, causing the shortest cutoff. Then see that the steam edges of the steam valves do not open the steam port, or if such position cannot be obtained then only open the amount of lead when the crank is on the dead center. Then mark off about 0.25 of the stroke on the guide and with the crosshead there adjust the rods to the steam valves to cause them to close the steam port.

When setting the exhaust, set them open about 1/16 in. when the crank is on the dead center opposite to that card where we are setting the valve.

In the card shown the compression on the crank end is too high and the rod to that exhaust valve should be shortened, excessive lead is indicated by the outward inclination of the admission line so the crank steam valve rod should be lengthened, the whole gear squared as in the preceding paragraphs when better results will be obtained. Receiver.

Use for Discarded Tracings

Old and discarded tracings on cloth are of no value to anyone, but they would make good bandages and handkerchiefs for the soldiers. In every drawing-room there are a great many such tracings that will never be of any use. These could be washed, ironed and turned in to the Red Cross. Any laundry should wash and iron these free of charge, but if these old tracings are sent prepaid to us, we will run them through our shop laundry. After they have been washed, they will be made into handkerchiefs and bandages and turned over to the Red Cross. Now is time to clean out your old files.

Charles W. Shartle,
President, Shartle Bros. Machine Co., Middletown, O.

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Saving Coal a War Measure

It needs no argument to prove that the saving of coal in a power plant is an important contribution to the conduct of the war; but the New England Coal Committee has done well to emphasize this fact in a recent statement to fuel users signed by its sub-committee on power plant economy. We can see at once that a reduction in the fuel consumption releases certain land and water transportation capacity for overseas service, speaking broadly. In doing this, it saves labor and provides a larger supply of fuel for the actual propulsion of ships through the zone of hostilities and for the operation of locomotives in war service in this country and in Europe. Every fireman who saves a few pounds of coal daily by careful work is thus a contributor to the advance of the forces of liberty up to the railhead nearest the enemy's trenches, and it should be an inspiring thought to those who, like many others in the power industry, are working faithfully in inconspicuous places to do their humble but important duty in these momentous times.

The committee wisely calls attention to the savings in fuel which may be secured at nominal cost through the cleaning of tubes and stoppage of leaks in brickwork, realizing that it will be out of the question to accomplish any sweeping improvements in station equipment *de novo* this winter in time to realize the maximum results of engineering investigation, on account of the shortage of materials and machinery. An interesting offer by the sub-committee places at the disposal of any power plant owner at cost or thereabouts the services of an inspector who will visit the plant and report upon possible betterments leading to improved use of fuel. In times of peace, such work clearly should be done at a profit; the services of an engineering expert justify a substantial margin over cost as much as do those of legal counsel; and even now, costs should be figured very liberally indeed, in order to cover the extraordinary expense of doing anything worth while compared with former conditions. No stigma should be attached to the engineer in private practice who charges a fair price for his services under present conditions unless he feels that he is in a position financially to give his services to the public welfare. We commend the patriotic spirit of the committee in offering to furnish skilled advice for power plant users at this time at cost; the main point is to insure saving of fuel per unit of output by every proper means, and whoever contributes to this end, whether with or without charges which would be regarded as normal in peace times, is forwarding the great cause to which we are now dedicated heart and soul.

Meeting the Emergency

Compared with European practice, the power plants in this country, due undoubtedly to the impression regarding an apparent inexhaustible supply of coal and the comparatively low prices demanded up to the last few years, have been most extravagant in the use of this fuel. Recent rapidly rising costs followed by our present national emergency have, however, forced engineers to give the matter serious consideration, not only from a standpoint of economy, but also as a means of conserving

our natural resources and indirectly as an aid to win the war.

The issue must be met. There is no way of evading it if the great majority of isolated plants are to continue to exist and retain their positions in the field of power plant engineering.

Many schemes tending to reduce operating costs and in that way combat the declining purchasing power of the dollar have been advanced of late, as we are told by the daily press, some demagogue has succeeded in attracting the attention of a few members of our national body of lawmakers to some secret means whereby he intends to propel ships by methods and at a cost heretofore unknown or undreamed of. Again, apparently something for nothing.

The engineer, and, in fact, the average layman, will, however, not turn a very receptive mind to any such nonsense, for he knows full well that any appreciable reduction in fuel consumption can only and will only be brought about by employing to the best advantage the fuel and equipment at present available. Miracles will not be wrought and the results desired will be realized only by the application of common sense and our knowledge of the physical and the chemical sciences. An example of this is found in the new power plant of the Mercy Hospital, described in this issue of Power Plant Engineering. The installation is typical of a modern isolated plant, but by means of a little forethought and study of existing and probable future conditions, the designers have brought about the erection of a plant which with proper operation should show a high degree of efficiency. We refer to the dual form of drive employed in connection with some of the auxiliary apparatus. The stokers and some of the pumps have been so equipped that either steam or electric drive can be employed, the former when the demand for exhaust steam is the greatest and the electrical load the heaviest, and the latter when conditions are such as would otherwise result in the waste of much steam and a heavier electric load may be desirable.

Some may question the advisability of such an arrangement, and perhaps even condemn it, but we believe that with close attention to load conditions and program of operations, the results to be realized will indicate a material reduction of operating costs, notwithstanding probably slightly greater first costs.

A COMMITTEE representing the machinery and machine tool trades has been formed to further the interests of the second Liberty Loan now being floated by the Government, and has established headquarters on the 16th floor, 334 Fourth Ave., New York City. All manufacturers of machinery and machine tools and their employes are invited to communicate with the secretary, Geo. J. Low, at the above address for full information and subscription blanks.

THE DEPARTMENT OF COMMERCE will hold an exhibit at the Southern Commercial Congress, Hotel Astor, Oct. 15 to 17, in which the different subdivisions, including the Bureau of Fisheries, Bureau of Foreign and Domestic Commerce, Bureau of Census, Bureau of Lighthouses, Steamboat Inspection Service, and Coast and Geodetic Survey, will be represented. Exhibits will show the activities of each Bureau, and will be of great interest. Dr. Geo. C. Havenner will have general charge of the installation of the exhibit.

Food Control

LITTLE thought was given to the question of food supply by the European nations when they went into the war. Even Germany, says Mr. Hoover, with all its preparation, had not foreseen that, with millions of men taken from production and thousands of fertile square miles laid waste, the world's cupboard would quickly develop symptoms of bareness.

Every country at war has tried some method of organizing food supply and distribution—price setting, regulation of producing and distributing trades, rationing—and the one which got the earliest and best methods secured the greatest war efficiency. Russia, with probably the greatest food producing possibilities in Europe, but no food control, has revolution and disorganization. Germany, with a food situation which might easily have become embarrassing, has been able to maintain efficiency.

Whether we like it or not, to use Mr. Hoover's phrase, we must either control the food supply to make the supply go around among the hungry nations, while keeping ourselves well nourished at reasonable prices and avoiding lavish methods and waste; or if we let appetite control, wages will rise as prices rise, due to increase of bonds and obligations. Food control is better because wage rise is slow and uneven, and for many salaried workers there will be no rise. The food situation is a loaded bomb, which unless carefully handled may explode and wreck the business structure. Hence food control is a most practical business and calls for the best leadership and the heartiest cooperation.

Food Pledge Week begins Oct. 21. The pledge for men is printed below, and anybody who is willing to help should clip it out, sign and send to Food Administration, Washington, D. C. There are no fees or dues; just the patriotic personal effort to economize food and influence others to do likewise. Practical methods are to eat as little wheat bread as circumstances permit; to eat meat not more than once a day; to reduce the use of butter, sugar, sweet drinks and candy to a minimum; to eat more corn, rye and oatmeal, more fruit and vegetables, more fish and poultry; to avoid waste and overeating; to urge in home and restaurants the need of food economy.

If all will do this, the maximum of concentrated food values which can be shipped in least space will be available for sending to our allies and soldiers abroad.

The food pledge follows:

To the United States Food Administration:

I pledge myself to use the practical means within my power to aid the Food Administration in its efforts to conserve the food supplies of the country, and, as evidence of my support, I wish to be enrolled with yourselves as a volunteer member of the Food Administration.

Name .....

Street .....

City..... State.....

National Smoke Prevention Association

TWELFTH ANNUAL CONVENTION, COLUMBUS, O., SEPT. 25-27, 1917

EVERY year the meetings of the Smoke Prevention Association have been marked with more and more effectiveness, and the convention at the Hotel Deschler, Columbus, Ohio, on Sept. 25-27, 1917, was another milestone on the path of progress.

The smoke prevention movement was originally started by enthusiasts, who were interested on the aesthetic side and who realized the great detriment to health from poisoning the atmosphere with smoke gases, the marring of the beauty of the city, the deterioration of shelf goods, and the rendering of the work of the household so much more onerous, and in a thousand ways making life in our great cities less worth living. Starting in this way, the movement has now developed into a great organized effort to conserve fuel. Smoke long looked upon as an indication of business prosperity and efficiency, in the light of modern science now is found to be a proof of negligence and inattention, of ignorance of scientific laws that lie behind the process of combustion.

"Proportioning a Chimney on the Fuel Basis" was the title of a paper read by Henry Misostow of the Chicago Smoke Inspection Department.

"The object of building a chimney," he says, "is twofold: First, it should deliver sufficient fresh air to fire in order to maintain combustion; second, it must discharge the product of combustion into the atmosphere. The chimney that will accomplish this work the cheapest is the chimney to be preferred, provided the quality of the work is not impaired.

"Chimney height is determined by the amount of draft required. In case the chimney must be built higher than this, the area per pound of chimney gas can be reduced in inverse ratio to the square root of the height. Area is determined by quantity of gas per second, and velocity. A stack velocity of 25 ft. per sec. is a good working velocity. For sharp, short peak loads a velocity of 30 ft. per sec. may be used. Chimney friction loss per foot under 30 ft. velocity per second will be inside of 0.001 in. of water. Gas weight may be obtained from quantity of fuel required. Volume of gas is proportional to the temperature, and this may be taken as 450 deg. F. In all calculations, absolute temperature must be used. Draft required, divided by available draft of foot height, will give stack height.

"Available draft per foot chimney for 450 deg. F., average stack temperature is equal to the actual difference in weight of gases inside and outside of the chimney, expressed in inches of water per square inch, less 0.001 in., friction loss.

"Composition of chimney gases can be taken as 6.5 per cent of CO_2, 11.5 per cent of O_2, and the rest nitrogen, and from this the weight and volume can be obtained. Actual composition of chimney gases varies slightly; it contains a trace of CO, SO, SO_2, and slightly more nitrogen than was in the air, and this is why CO_2 and O_2 is 18 per cent in chimney gases instead of over 20 per cent, as in free air.

"The amount of combustible required to provide desired amount of heat can be taken as composed of pure carbon, and its heating value of 14,000 B.t.u.

"Combined efficiency of boiler and furnaces can be considered as 60 per cent for high, and 40 per cent for low-pressure plants.

"The material presented in the paper, reduced for quick reference in practical work is as follows:

1. Draft available per foot of chimney above grate is 0.0053 in. of water.
2. Combustibles per horsepower, 4 lb.
3. Area required per pound of combustible will be 1.1 sq. in. for high-pressure plants.
4. Area correction for chimney above 150 ft. in height per pound of combustible is

$$\frac{1.1 \times 12.24}{\text{Square root of chimney height}}."$$

In the discussion of the paper, Mr. Misostow was asked if he had any formula to determine the difference between a round and a square chimney.

Mr. Misostow replied that he had investigated the proposition very conscientiously and had not been able to find any dead corner. If the area in a square chimney is equal to the area in a round chimney, one should be as efficient as the other.

W. C. Stripe, of the Westinghouse E. & M. Co., believed that the theory of lesser friction loss in a round stack is well justified, because it is a well-known fact that dust-laden air will travel in a helix, and the cross section of the gas path is a circle, which means that all of the square corners will result in quiescent areas creating eddy currents which tend to reduce the available draft. In a circular stack none of these eddy currents in the horizontal plane are encountered. He based his opinion upon an investigation of the flow of dust-laden air ducts. He believed that there is a critical velocity below which the gases will flow in stream lines; and where they reach that critical velocity they will describe a helix. Whether or not they reach that in stack conditions Mr. Stripe was not prepared to state.

Royce L. Beers, engineer of the United States Radiator Corporation of Detroit, formerly for several years fuel engineer in the laboratory of the Bureau of Mines in Pittsburgh, read a paper entitled "The Smokeless Combustion of Coal." An abstract of Mr. Beers' paper and the discussion which followed will be published in a subsequent issue of Power Plant Engineering.

Those interested in the abatement of smoke from railway locomotives were given some valuable information in the following papers and discussions: The Effect of the Brick Arch on Locomotive Smoke Abatement, by J. T. Anthony, of the American Arch Co.; Pulverized Coal for Locomotives, by H. G. Barnhurst, chief engineer of the Fuller Engineering Co.; Firing Up Locomotives, by Allen Armer, general foreman of the Big Four Roundhouse, Columbus, followed by a demonstration at the New York Central roundhouse. Judge Maurice H. Donahue gave a discourse upon the subject of Government Supervision of Fuel.

W. C. Ross, a consulting engineer of Chicago, read a paper on "The Manufacture of Biproduct Coke and Its Effects on the Domestic Smoke Problem," in which the advantages of the use of coke were discussed and

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

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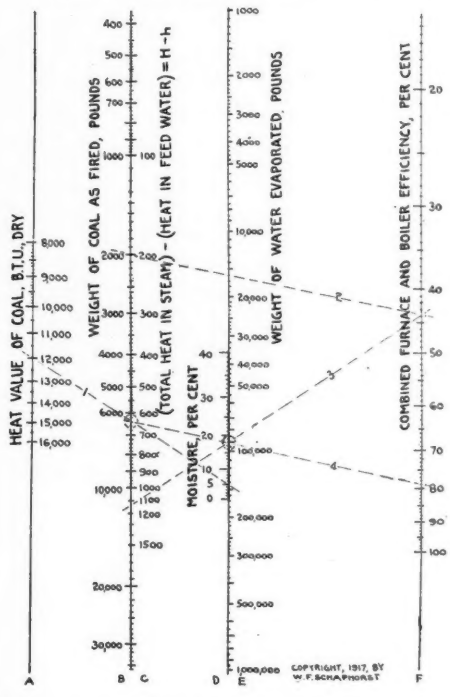
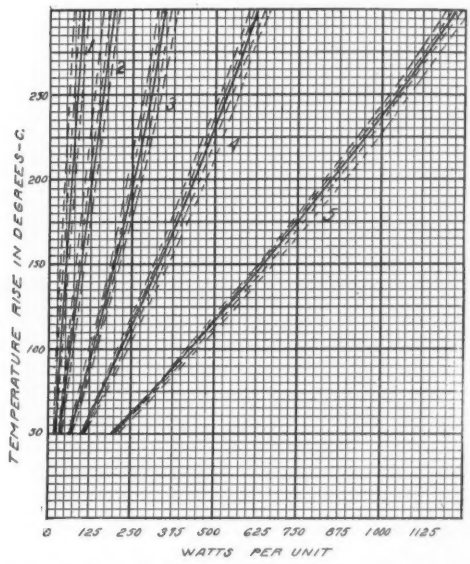
POWER PLANT ENGINEERING

FURNACE AND BOILER EFFICIENCY CHART


HEAT VALUE OF COAL, B.T.U. DRY
WEIGHT OF COAL AS FIRED, POUNDS
(TOTAL HEAT IN STEAM) - (HEAT IN FEED WATER) = H - h
MOISTURE, PER CENT
WEIGHT OF WATER EVAPORATED, POUNDS
COMBINED FURNACE AND BOILER EFFICIENCY, PER CENT
COPYRIGHT, 1917, BY W. F. SCHAPHORST

POWER PLANT ENGINEERING

RELATION OF TEMPERATURE RISE AND ENERGY LOSS PER RESISTOR UNIT OF MOTOR CONTROLLERS



Heavy lines are average values, dotted lines variations due to different cross sections of grids. Curves apply to only one size grid, but illustrate the effect of different classes of service. 1. Continuous. 2. Resistor in circuit 2 min. out of every 4 with 2 min. rest between. 3. One minute service and 3 rest. 4. Thirty seconds service with 3½ min. rest. 5. Fifteen seconds service in each 4 min. —The Electric Journal.

POWER PLANT ENGINEERING

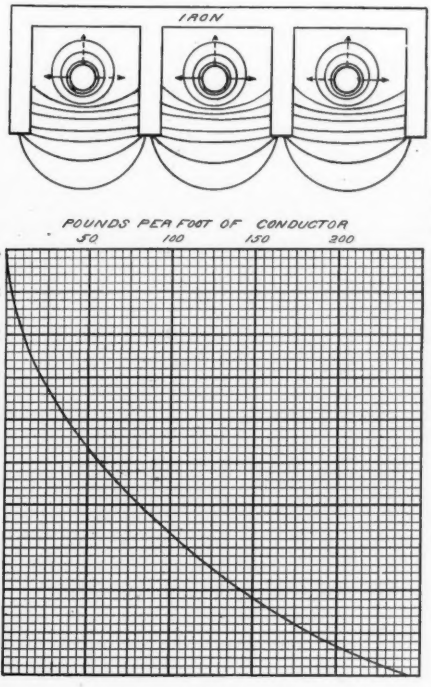
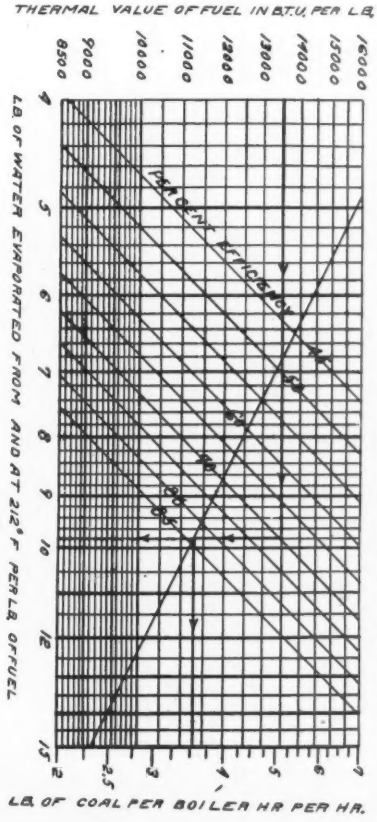


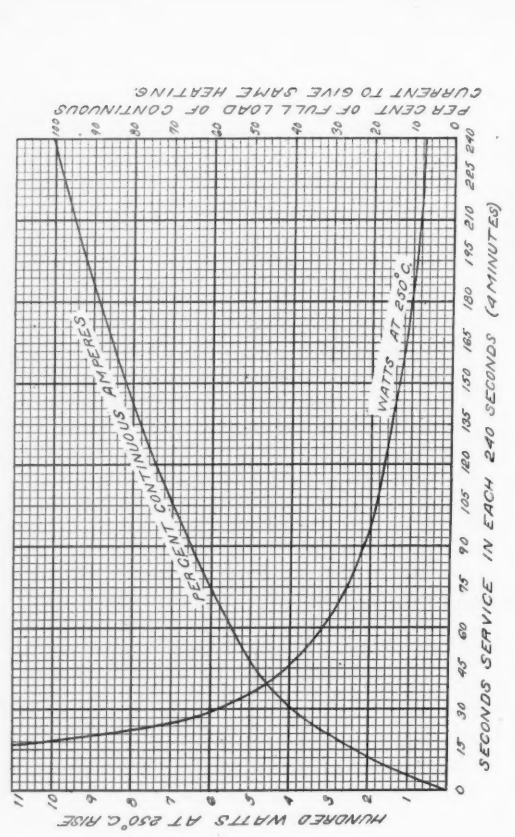
FIG. 1. RELATION BETWEEN CURRENT AND REPULSIVE FORCE OF THE TOP AND BOTTOM BUSSES

With a complete short-circuit on a 3-phase busbar system arranged as shown, conductors spaced 18 in. apart.

POWER PLANT ENGINEERING


THERMAL VALUE OF FUEL IN B.T.U. PER LB.
LB. OF WATER EVAPORATED FROM AND AT 212° F. PER LB. OF FUEL
LB. OF COAL PER BOILER HR. PER HR.
COAL REQUIRED PER BOILER-HORSEPOWER HOUR

ENERGY WHICH CAN BE DISSIPATED IN A GRID FOR DIFFERENT LENGTHS OF SERVICE


PER CENT OF FULL LOAD OF CONTINUOUS CURRENT TO GIVE SAME HEATING
PER CENT CONTINUOUS AMPERES
WATTS AT 230° C.
SECONDS SERVICE IN EACH 240 SECONDS (4 MINUTES)
HUNDRED WATTS AT 230° C RISE

—The Electric Journal.

TABLES USED IN DETERMINING FURNACE AND BOILER EFFICIENCY

TABLE I

Steam Pressure, Lb. per Sq. In., Absolute	Total Heat in the Steam H	Steam Pressure, Lb. per Sq. In., Absolute	Total Heat in the Steam H
5	1131.5	130	1187.8
10	1140.9	135	1188.7
15	1146.9	140	1189.5
20	1151.5	145	1190.4
25	1155.1	150	1191.2
30	1158.3	155	1192.0
35	1161.0	160	1192.8
40	1163.4	165	1193.6
45	1165.6	170	1194.3
50	1167.6	175	1195.0
55	1169.4	180	1195.7
60	1171.2	185	1196.4
65	1172.7	190	1197.1
70	1174.3	195	1197.7
75	1175.7	200	1198.4
80	1177.0	205	1199.0
85	1178.3	210	1199.6
90	1179.6	215	1200.2
95	1180.7	220	1200.8
100	1181.9	225	1201.4
105	1182.9	230	1202.0
110	1184.0	235	1202.6
115	1185.0	240	1203.2
120	1186.0	245	1203.7
125	1186.9	250	1204.2

TABLE II

Temperature of Feed Water deg. F.	Heat in the Water h	Temperature of Feed Water deg. F.	Heat in the Water h
32	0	125	93.1
35	3.02	130	98.1
40	8.06	135	103.2
45	13.08	140	108.2
50	18.10	145	113.3
55	23.11	150	118.3
60	28.12	155	123.3
65	33.12	160	128.4
70	38.11	165	133.4
75	43.11	170	138.5
80	48.09	175	143.5
85	53.06	180	148.5
90	58.04	185	153.6
95	63.02	190	158.6
100	68.01	195	163.7
105	73.0	200	168.7
110	78.0	205	173.7
115	83.0	210	178.8
120	88.1	212	180.8

RELATIVE ECONOMIC VALUE OF COALS

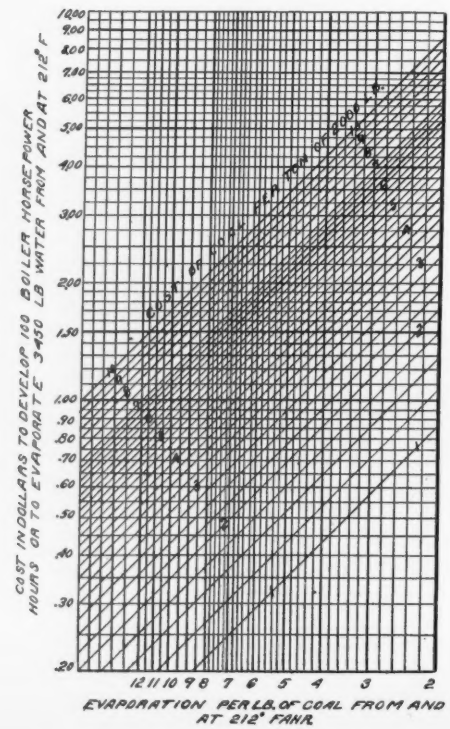
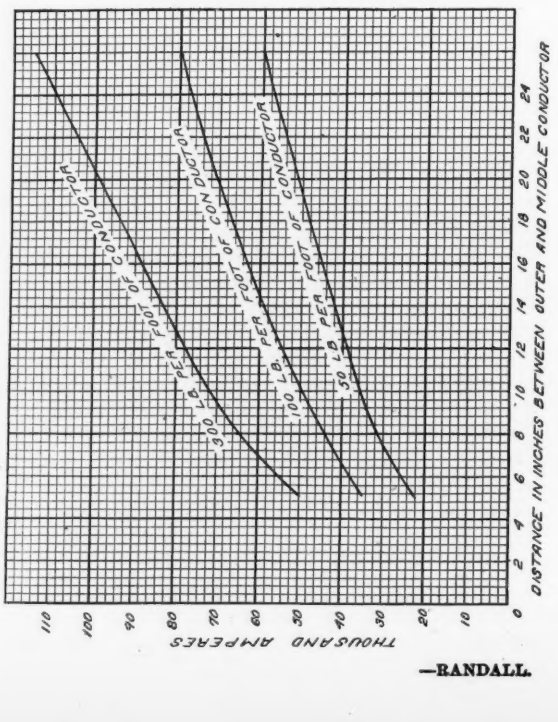

COST IN DOLLARS TO DEVELOP 100 BOILER HORSEPOWER HOURS OR TO EVAPORATE 3450 LB WATER FROM AND AT 212° F
EVAPORATION PER LB. OF COAL FROM AND AT 212° FAHR.

FIG. 2. REPULSION ON THE OUTER CONDUCTORS OF THE 3-PHASE SYSTEM SHOWN IN FIG. 1 UNDER SHORT CIRCUIT CONDITIONS


30 LB. PER FOOT OF CONDUCTOR
100 LB. PER FOOT OF CONDUCTOR
50 LB. PER FOOT OF CONDUCTOR
THOUSAND AMPERES
DISTANCE IN INCHES BETWEEN OUTER AND MIDDLE CONDUCTOR

—RANDALL.

the cost to produce coke was estimated. A significant statement made was "one drawback to the industrial use of coke in the past has been the cost, owing to so small a portion of the coal in the country being known as coking coal. However, according to information obtained from reliable sources there are methods or systems today which can successfully coke almost any coal, thereby greatly reducing the enormous freight charges which in the past have made the use of coke almost prohibitive."

The discussion following showed that the railroad men present were very strongly opposed to the burning of coke on locomotives, and several of them recounted very disagreeable experiences with it. Mr. Ross assured his hearers that the coke they used to know was a thing of the past and is now much better behaved, having had all of the sulphur removed from it by recent modern processes. This assurance, however, fell upon unwilling ears.

News Notes

REPUBLIC RUBBER CO. announces the appointment of Mark W. Roe as consulting engineer.

COMBUSTION ENGINEERING CORPORATION, New York, announces the recent death of its president, Royal Canfield Peabody.

JAMES F. O'KEEFE, formerly president of Curran Mfg. Co., has become general manager for Kieley & Mueller, Inc., manufacturers of Kieley Steam Specialties, 34 W. 13th St., New York.

FRANK L. PATTERSON & Co., and Benj. F. Kelley & Son announce a combination of their interests. Hereafter their joint business will be conducted under the name of the Patterson-Kelley Co., Inc., 26 Cortlandt St., New York.

THE SANFORD RILEY STOKER CO., Ltd., of Worcester, Mass., has had such an increased volume of business in the Riley Underfeed Stokers, that it has arranged for additional manufacturing facilities in Detroit, Mich., at the plant of the Murphy Iron Works. There will be no change in the management or policy of the Murphy Iron Works. They will continue the manufacture of the Murphy automatic furnace, increasing their manufacturing facilities as required for the production of Riley stokers. R. Sanford Riley, of Worcester, Mass., has been elected president of the Murphy Iron Works.

The B. F. Sturtevant Co., of Hyde Park, Mass., will continue to manufacture and act as selling agents for the Sanford Riley Stoker Co.

WORTHINGTON PUMP & MACHINERY CORPORATION has opened a branch sales office in the American Trust & Savings Bank Bldg., Birmingham, Ala. This office will take over a portion of the territory hitherto controlled from the Atlanta office, including all of Alabama, except the counties of Choctaw, Conecuh, Clark, Mobile, Monroe, Baldwin, Washington and Escambia, and all of the state of Florida, except the counties of Okaloosa, Escambia and Santa Rosa; also all of that portion of the state of Georgia south of the Seaboard Air Line running from Columbus to Savannah, Ga. Edward Stauverman will be in charge of the Birmingham office, while the Atlanta office, under the management of A. W. Jones, will continue to serve the state of North Carolina, South Carolina and that portion of Georgia north of the Seaboard Air Line.

THE HOMESTEAD VALVE MANUFACTURING CO., of Homestead, Pa., announces that it has almost completed the rebuilding of its manufacturing plant and office buildings, whereby it added about 75 per cent additional space to take care of the increase in its business.

In addition to adding more floor space in its factory and offices, the company has also added considerable new machinery and equipment, especially in the foundry where the production has been almost doubled in a short time.

With its added facilities, the company will be in a better position than ever to take care of rush orders promptly and, with its usual scrupulous attention, will endeavor to meet the requirements of its friends.

JOHN H. BARKER, well known as salesman and specialist in electrical power applications, and for 8 yr. connected with the Diehl Manufacturing Co., the last two as sales manager, has opened an office at 95 Liberty St., New York City, and will engage in the business of selling and installing complete electrical equipments for factories, including cranes and electrical industrial trucks.

THE UNITED STATES CIVIL SERVICE COMMISSION announces the following open competitive examinations for positions in the several ordnance establishments of the War Department or in or under the office of the Chief of Ordnance, War Department, Washington, D. C. The salaries named are for entrance.

Mechanical engineer, artillery ammunition, $3000 to $3600 a year.

Mechanical engineer, experimental work, $2500 to $3000 a year.

Mechanical draftsman, $1000 to $1400 a year.

Apprentice draftsman, $480 a year.

Inspector of artillery ammunition, $1500 to $2400 a year.

Inspector of field artillery ammunition steel, $1500 to $2400 a year.

Assistant inspector of field artillery ammunition steel, $3.50 to $5 a day.

Inspector of ammunition packing boxes, $3.52 a day to $1800 a year.

Inspector and assistant inspector of powder explosives, $1400 to $2400 a year.

Inspector of ordnance equipment, $1500 to $2400 a year.

Assistant inspector of cloth equipment, $80 to $125 a month.

Assistant inspector of leather, $100 to $125 a month.

Assistant inspector of small hardware, $80 to $125 a month.

Assistant inspector of textiles, $80 to $125 a month.

Assistant inspector of leather equipment, $100 to $125 a month.

Clerk qualified in business administration, $1200 to $1500 a year.

Index and catalog clerk, $1000 to $1200 a year.

The examination for index and catalog clerk is open

to both men and women; the other examinations are open only to men.

The Government urgently needs men for the work above indicated, and qualified persons are urged, as a patriotic duty, to apply for examination. Until further notice, applications for the positions named will be received at any time by the United States Civil Service Commission, Washington, D. C. Papers will be rated promptly. Applicants will not be required to appear at any place for examination, but will be rated principally upon the elements of education, training, and experience, as shown by their applications and by corroborative evidence.

Full information concerning examinations, application blanks, etc., may be obtained by calling in person upon the secretary of the local board of civil service examiners at the post office in any city in which city delivery of mail has been established, or by communicating with the United States Civil Service Commission, Washington, D. C.

Catalog Notes

BULLETIN NO. 29, of Nagle Corliss Engine Works, Erie, Pa., illustrates and describes short belt-driven single-stage air compressors.

THE OHIO BRASS CO., Mansfield, O., is sending out a new circular illustrating its different types of valves.

ARMSTRONG MACHINE WORKS, Three Rivers, Mich., has lately issued a 24-page catalog relating to Armstrong steam traps.

FROM STRONG MACHINERY & SUPPLY CO., 21 Walker St., New York, we have received a pamphlet describing and illustrating Strong's Ironclad high-pressure gage glasses.

FORM P INDUCTION MOTORS, two and three-phase, squirrel-cage type, 60-cycle, ½ to 3 hp., are illustrated and described in Bulletin 182 of Crocker-Wheeler Co., Ampere, N. J.

THE FARNSWORTH SYSTEM of returning condensation direct into boilers under pressure, Farnsworth Duplex Boiler Feeder draining vacuum return line systems, and the company's traps and other specialties, are illustrated in a folder from Farnsworth Co., Conshohocken, Pa.

CREATING AN INDUSTRY is the title of a 54-page booklet which gives a brief history of the art of casting metals from prehistoric to modern times, illustrating methods during various periods, and finally relating the achievements of Doehler Die-Casting Co., Brooklyn, N. Y.

WORTHINGTON outside packed plunger pattern pumps for general service are described and illustrated in a new bulletin, W-400, from Worthington Pump and Machinery Corporation, New York.

Another bulletin, W-602, on the subject of Worthington turbine pumps, was also recently received.

Bulletin W-600-A from the same company describes and illustrates volute centrifugal pumps.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

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Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer; have Ohio engineers' and boiler inspectors' licenses. Experienced with absorption method of manufacturing gasoline. Good references. Address Box 481, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-15-1

POSITION WANTED—By young man as oiler in large central station, with 7 years' experience with Corliss engines up to 400 hp., d.c. generator. I. C. S. graduate on complete Steam Engineering. Age 27. Married. Best of reference. Will go any place. Address Box 493, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—As helper or oiler in small or large plant. Will come at once. Sober and industrious. Will consider reasonable salary. Address Box 494, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—By young man as oiler or assistant engineer in or around Chicago, with chance of advancement. Eight years' experience; ready to start work at a week's notice; references. Address Box 492, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—As engineer in small steam plant not over 125 hp., by young man. Steady and sober habits. More than 5 years' experience as engineer in grain elevator. Good mechanic. Address Box 123, Diixon, Ia. 10-15-1

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 10-15-1

POSITION WANTED—Young man wishes a position as oiler or assistant to the engineer in a plant in New York City. One year practical experience. Address A. Benora, 38 Park Hill, Yonkers, N. Y. 9-1-3

POSITION WANTED—By young man as assistant engineer or assistant switchboard operator in plant in or near Newark, N. J., where there is a chance for advancement. Three years' practical experience. Address Wm. Wykes, 358 S. 7th St., Newark, N. J. 10-1-1

POSITION WANTED—By practical engineer of 15 years' experience. Am familiar with a.c. and d.c. generators and motors, also refrigerating machinery. Am 38 years old, married and strictly sober. Good references. E. W. Jones, Genl. Del., Metropolis, Ill. 9-15-2

POSITION WANTED—Will represent some engineering firm in Mexico or take a position as chief engineer. Can operate electric, ice or power plant. Can speak, read and write Spanish. Am practical and progressive engineer. Will consider only well rated concern. Am colored. C. D. Bassett, Engineer, 183 N. Wabash Ave., Chicago, Ill. 9-15-2

POSITION WANTED—By young man as engineer in power plant. Seven years' experience in gas works and small central station operating. A-1 references. Present salary $1,300. Married. Age 25. Address Box 490, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-15-2

POSITION WANTED—As chief engineer by middle-aged man, with 20 years' experience; famliiar with a.c. and d.c. generators and motors; also absorption refrigerating machinery and steam heating. Married and strictly sober. Present salary $1500. In present position 7 years. Desire change. Good reference. A. J. Marshall, Plainfield, Ind. 10-15-1

POSITION WANTED—As engineer or oiler in power or ice plant. Have had 15 years' experience. Fred J. Waite, 659 Douglas Ave., Aurora, Ill. 10-15-1

POSITION WANTED—By a licensed operating engineer with 5 years' experience. At present employed, but would like to make a change and locate in or near Philadelphia. Will consider position as operating or chief engineer at $150 per month. Can furnish best of references from present employer. Address Horace D. Ferrell, Box 501, Marcus Hook, Pa. 10-15-1

POSITION WANTED—Chief engineer desires change of location. Competent to handle large plant. Experienced with a.c. and d.c. machinery, irrigating machinery, ammonia compressors (practical ice-maker), gas engines and air compressors. Can install and do repairs. Not liable to conscription. Address Box 495, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—For immediate service two (2) experienced salesmen, thoroughly familiar with high-grade centrifugal and direct-acting pumps; one for New England and one for Philadelphia. Address Box 496, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

For Sale

FOR SALE—Edon (Ohio) Furniture Company plant for sale. Full equipment for manufacturing all kinds of woodwork. Saw mill and only feed mill of the town in connection. First class shipping facilities. Good town. Great bargain. Owner deceased. J. H. Schrider, Bryan, Ohio. 10-1-2

FOR SALE—250-volt, direct-connected units. 100-kw. G.E. with Ridgway engine, $2200; 75-kw. G.E., 3-wire, with Buckeye engine, $2000; 50-kw. Allis with Harrisburg, $1200; 30-kw. G.E. with Harrisburg, $900. Power Machinery Exchange, Jersey Ciity, N. J.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to gete some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes with back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Our Nation's Need for Cooperation

Unprecedented industrial demands forced upon the belligerent countries by the necessities of war have increased enormously the productive capacities of these nations. And, while many things heretofore considered impossible have been and continue to be accomplished, still greater efforts will have to be put forth in order for us to realize a victorious conclusion of the conflict in which we are now engaged.

But the question arises—"How may we cope with such seemingly gigantic demands when the majority of those we have depended upon most are being called to the fighting line, away from the ranks of the producers?"

Reviewing the experiences of our allies the question may be readily answered by—Less Waste, Economy, Greater Effort and Increased Efficiency on the part of not only the Nation, but also the individual, thus calling forth a spirit of cooperation perhaps heretofore unknown.

Rightfully may the power plant be considered the heart of the body of industry, for without the flow of energy emanating from this source the life of modern business would soon cease. And if, therefore, the bigger results demanded from industry are to be realized, then in the power plants, as in other departments, wasteful methods of operation must be abandoned and a degree of cooperation established amongst the employes which will be bound to result in an efficiency which but a comparatively short time ago was considered impossible of attainment.

Wasteful methods must be abandoned — economy must be adopted. This, however, cannot be done unless you are provided with machines and equipment designed and built to meet present day conditions. If, therefore, you have in your charge any equipment which you believe in any way impairs the efficiency of your plant, it is a duty you owe yourself, your employer and your country to replace it at once.

But before doing so, turn to the advertising pages of POWER PLANT ENGINEERING—scan them carefully—find out who is manufacturing or handling the particular apparatus you need. Then write to the advertisers telling them just what you want, where you want to use it and how you want to use it. They'll be glad to cooperate with you in every way possible.